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ABSTRACT

Good indoor air quality contributes to a favorable learning environment for students, productivity for teachers and staff, and a sense of comfort, health, and well-being for all school occupants. The goal of this kit is to provide clear and easily applied guidance that will help prevent Indoor Air Quality (IAQ) problems and resolve such problems promptly if they do arise. It recommends practical actions that can be carried out by the school staff without the need for training, and is flexible enough to conform to the specific needs of the school. The kit includes an IAQ coordinator's guide, various checklists, IAQ problem solving wheel, and an indoor air pollution guide for health professionals. The coordinator's guide is divided into two basic sections: background information and specific activities. Specific activities involve two major actions: the management of pollutant sources and the use of ventilation for pollutant control. The background information and activities in this voluntary program are directed toward existing schools in the K-12 range, but colleges, universities, and preschool and daycare centers could benefit by application of the principles and activities presented. (JRH)

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ED 399 139

Indoor Air Quality

Tools For Schools

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IAQ Coordinator's Guide

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Note to School Officials

Good indoor air quality contributes to a favorable learning environment for students, productivity for teachers and staff, and a sense of comfort, health, and well-being for all school occupants. These combine to assist a school in its core mission — educating children.

Rising energy costs encourage the development of tighter buildings and a reduction in the amount of outdoor air brought into schools for ventilation. In addition, school operating and maintenance budgets are often reduced to minimal levels. These actions, combined with the variety of indoor sources of contaminants — building materials, furnishings, cleaning agents, pesticides, printing and copying devices, combustion appliances, tobacco products, allergens, fungi, molds, bacteria, viruses, radon, and lead — can reduce the quality of the indoor environment, and consequently affect the health and well-being of school occupants.

The number of children with asthma increased by 60% during the 1980s, and poor indoor air quality can trigger asthmatic episodes. In addition to myriad health consequences, poor air quality is becoming increasingly costly for schools due to the potential for expensive investigation and hasty solutions during a major indoor air problem, higher heating and cooling costs, damage to the physical building structure and mechanical equipment, and higher liability. For these reasons, air quality in schools is of particular concern. Proper maintenance of indoor air is more than a "quality" issue, it encompasses safety and stewardship of the taxpayer's investment.

In response to this era of tight school budgets, this guidance is designed to allow you to prevent and solve the majority of indoor air problems with minimal cost and involvement. You can accomplish this using current school staff to perform a limited and well-defined set of basic operations and maintenance activities.

The commitment to address indoor air quality (IAQ) starts with the highest level of school administration. You have the ability to identify and empower an IAQ Coordinator (page 5), and the authority to ensure that your school staff has the incentive to carry out the problem solving and problem prevention guidance provided in this kit.

As you read this Guide, especially the first six pages, and turn it over to your staff to implement, EPA urges you to maintain a personal involvement in this issue.

This common-sense guidance is designed to help you prevent and solve the majority of indoor air problems with minimal cost and involvement.

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Note: The IAQ Coordinator's Forms, IAQ Backgrounder, IAQ Checklists, and IAQ Problem Solving Wheel are separate pieces that are supplied with this Guide (see diagram on page 2).

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EPA appreciates the time that numerous organizations and individuals took to share ideas, experiences, and comments on the drafts of *Indoor Air Quality Tools for Schools*. Many of these ideas have contributed to the usefulness and completeness of this kit.

Within EPA, project management was provided by Bob Thompson, who developed the concept and much of the content of *Indoor Air Quality Tools for Schools*. The insights and encouragements of Bob Axelrad, Scott Bowles, Sandra Eberle, Elissa Feldman, John Girman, and Dave Mudarri were especially valuable throughout the development of the document. Victoria Drew and Connie Thomas provided exceptional assistance in contract management and editing, and Lisa Adams, Allene Gillam, and Mary Vance are gratefully acknowledged for their office support.

Disclaimer

Any information gathered as a result of using this kit is for the benefit and use of the local school or school district. EPA does not require retention or submission of any information gathered, and EPA has no regulatory or enforcement authority regarding general indoor air quality in schools. This kit has been reviewed in accordance with policies of the U.S. Environmental Protection Agency. Information provided is based upon current scientific and technical understanding of the issues presented. Following the advice given will not necessarily provide complete protection in all situations or against all health hazards that may be caused by indoor air pollution.

Mention of any trade names or commercial products does not constitute endorsement or recommendation for use.

Warning

Please note the following as you prepare to use this kit:

- The guidance in this kit is not intended as a substitute for appropriate emergency action in the event of a hazardous situation that may be immediately threatening to life and safety.
- Modification of building functions, equipment, or structure to remedy air quality complaints may create other indoor air quality problems and may impact life safety systems and energy use. A thorough understanding of all the factors that interact to create indoor air quality problems can help to avoid this undesirable outcome. Consult with professionals if it becomes necessary.
- In the event that medical records are used while evaluating an IAQ problem, confidentiality must be maintained.

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Action Kit Overview

The goal of this kit is to provide clear and easily applied guidance that will help prevent indoor air quality (IAQ) problems and resolve such problems promptly if they do arise. It recommends practical actions that can be carried out by the school staff without the need for training, and is flexible enough to conform to the specific needs of your school.

The background information and activities in this voluntary program are directed toward existing schools in the kindergarten through twelfth grade range, but colleges, universities, and pre-school and day-care centers could benefit by application of the principles and activities presented. In addition, many of these principles could also be applied by architects and engineers when planning new schools or major renovations.

Who Coordinates This Guidance

A team leader, known as the IAQ Coordinator, is needed to fully administer the guidance recommended in this Guide. Please refer to Section 3, *Roles and Functions of the IAQ Coordinator*, for information that will help with selecting an IAQ Coordinator.

Why Follow This Guidance

Section 2, *Why IAQ Is Important to Your School*, provides information on the benefits of understanding and applying this guidance to maintain good indoor air quality. Three additional reasons to implement this guidance include:

- The expense and effort required to prevent most IAQ problems is much less than the expense and effort required to resolve problems after they develop.
- Many IAQ problems can be prevented by educating school staff and students about the factors that create them. When IAQ problems do arise, they can often be resolved using skills available in-house.
- If outside assistance is needed to solve an IAQ problem, the best results will be achieved if school officials are informed customers.

How This Kit Is Organized

The indoor air quality guidance in this kit can be divided into two basic categories: background information and specific activities. Once you understand the basic principles and factors that influence indoor air quality in your school, you will note that the specific activities involve two major actions — the management of pollutant sources, and the use of ventilation for pollutant control.

This guidance is organized around the use of an IAQ team, with the IAQ Coordinator fulfilling leadership and administrative roles, and with the team members each performing specific activities as outlined in Section 4.

WHERE THE IAQ COORDINATOR STARTS

IAQ Coordinator selected (Section 3)
Read Sections 1-13, review reminder
Complete checklist, Activate the IAQ Management Plan
Complete IAQ Coordinator's Checklist

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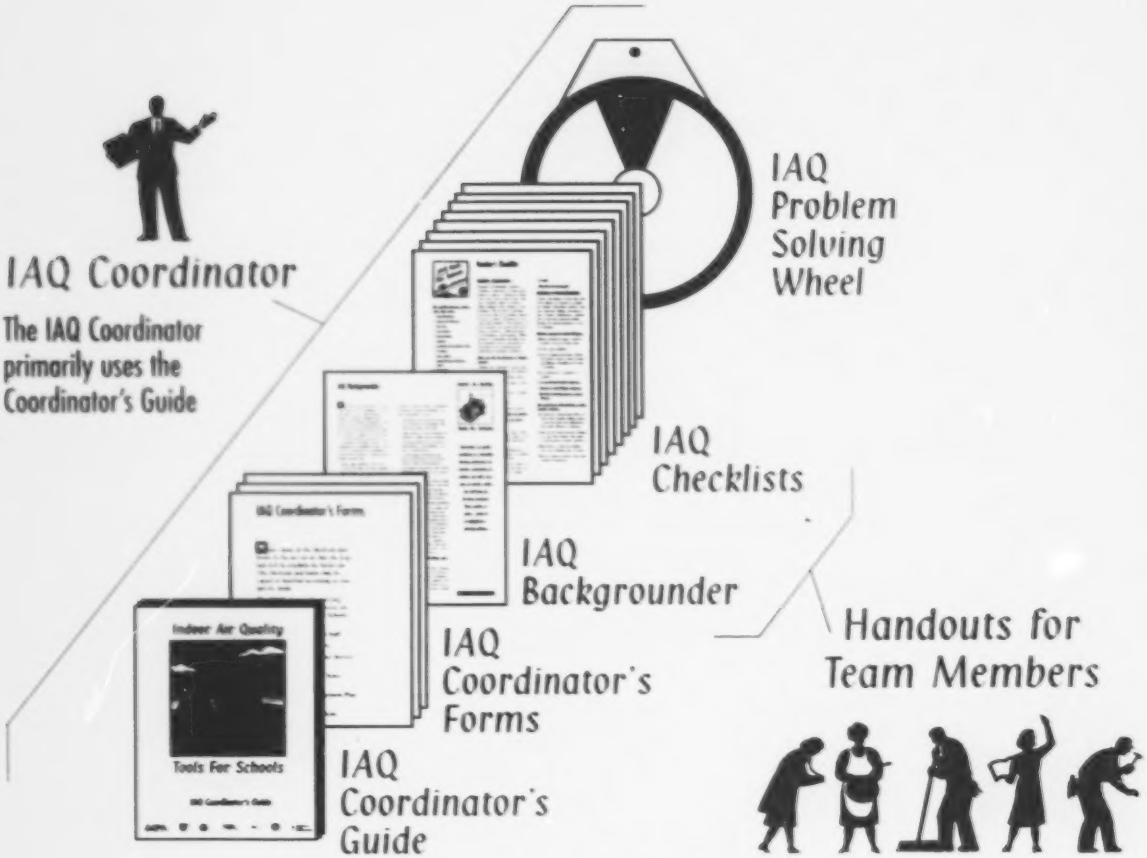

There are IAQ Checklists for:

- Teachers
- Administrative Staff
- Health Officer
- Ventilation
- Building Maintenance
- Food Service
- Waste Management
- Renovation and Repairs

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Why IAQ Is Important to Your School

2

Good indoor air quality contributes to a favorable learning environment for students, productivity for teachers and staff, and a sense of comfort, health, and well-being. These elements combine to assist a school in its core mission — educating children.

Most people are aware that outdoor air pollution can damage their health but many do not know that indoor air pollution can also have significant health effects. Environmental Protection Agency (EPA) studies of human exposure to air pollutants indicate that indoor levels of pollutants may be 2-5 times, and occasionally more than 100 times, higher than outdoor levels. These levels of indoor air pollutants may be of particular concern because most people spend about 90% of their time indoors.

For the purposes of this guidance, the definition of good indoor air quality management includes:

- control of airborne pollutants
- introduction and distribution of adequate outdoor air
- maintenance of acceptable temperature and relative humidity

Temperature and humidity cannot be overlooked because thermal comfort concerns underlie many complaints about "poor air quality." Furthermore, temperature and humidity are among the many factors that affect indoor contaminant levels.

Why IAQ Is Important

In recent years, comparative risk studies performed by EPA and its Science Advisory Board have consistently ranked indoor air pollution among the top five environmental risks to public health. Good indoor air quality is an important component of a healthy indoor environment, and can help schools reach their primary goal.

Failure to respond promptly and effectively to IAQ problems can have the following health, cost, and educational process consequences:

- increasing long- and short-term health problems such as cough, eye irritation, headache, asthma episodes, and allergic reactions, and, in rarer cases, life-threatening conditions such as severe asthma attacks, Legionnaire's disease or carbon monoxide poisoning
- promoting the spread of airborne infectious diseases
- producing an unfavorable learning environment for children
- reducing productivity of teachers and staff due to discomfort, sickness, or absenteeism
- accelerating the deterioration and thus reducing the efficiency of the school's physical plant and equipment
- increasing the risk that school rooms or buildings will have to be closed, and occupants temporarily relocated
- straining relationships among the school administration and parents and staff
- generating negative publicity that could damage a school's or administration's image and effectiveness
- creating potential liability problems

Indoor air problems can be subtle, and do not always produce easily recognized impacts on health, well-being, or the physical plant. In some cases, only one or a few individuals may be strongly affected by what appears on the surface to be psychosomatic in nature because the majority of the school population does not appear to have any symptoms.

Children may be especially susceptible to air pollution. The same concentra-

tion of pollutants can result in higher body burden in children than adults because children breathe a greater volume of air relative to their body weight. For this and the reasons noted above, air quality in schools is of particular concern. Proper maintenance of indoor air is more than a "quality" issue, it encompasses safety and stewardship of our investment in the students, staff, and facilities.

Unique Aspects of Schools

Unlike other buildings, managing schools involves the combined responsibility for public funds and child safety issues, which can cause strong reactions from concerned parents and the general community. Other unique aspects include:

- occupants are close together, with the typical school having approximately four times as many occupants as office buildings for the same amount of floor space
- budgets are tight, with maintenance often receiving the largest cut during budget reductions
- the presence of a variety of pollutant sources, including art and science supplies, industrial and vocational arts, home economic classes, and gyms
- a large number of heating, ventilating, and air-conditioning systems, placing an added strain on maintenance staff
- as schools add space, the operation and maintenance of each addition is often different
- schools sometimes use rooms, portable classrooms, or buildings which were not originally designed to service the unique requirements of schools

Role and Functions of the IAQ Coordinator

3

IAQ management within schools will not just happen — it requires leadership. Leading people is an important function of the IAQ Coordinator, because it is people who both affect and are affected by the quality of the indoor air. People make decisions — decisions about what materials to bring into the school, how those materials are used, how the school building and ventilation systems are operated, how they are maintained, and how to respond to problems. Effective leadership will ensure that an informed choice is made at each of these decision points.

Functions of the IAQ Coordinator

The primary role of the IAQ Coordinator is team management. All of the "technical" activities can be delegated. Additionally, a staff person can assist the IAQ Coordinator in many of the activities, such as copying and disseminating the Action Packets to the staff, and summarizing responses from the team member Checklists. The primary management functions are:

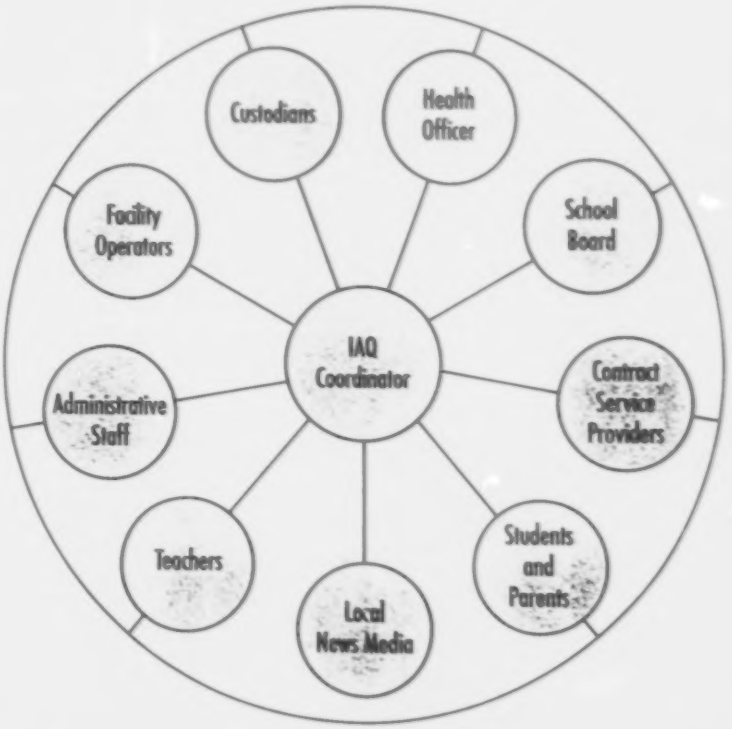
Team Leader: Coordinates an "IAQ Team," as noted in the figure to the right, and encourages a sense of shared responsibility and cooperative effort. Provides the team with the Action Packets supplied in this kit, and implements the IAQ Management Plan (Sections 6 through 9).

Emergency Response: Prepares for emergency response as outlined in the IAQ Management Plan. Follows the guidance and makes decisions as outlined in *Resolving IAQ Problems* (Sections 10 through 13). Determines if and when outside professional assistance is needed, and coordinates their activities.

Key Authority: Disseminates IAQ information, registers IAQ complaints and directs the response, and communicates IAQ issues and status to school administration, staff, students, parents, and the press.

Who Is the IAQ Coordinator?

The choice of IAQ Coordinator will probably depend on the organizational structure of your school system. In larger school districts, the IAQ Coordinator may be a district level administrative person, such as the business official, a health and safety officer, or the facilities manager. In smaller school systems, the IAQ Coordinator may be the Principal or Vice Principal.



In either case, based on the functions and level of leadership needed, this position would usually best be filled by upper level administration in the school district or school, because these positions have the budget, staffing, and administrative authority. These positions are also in the proper line of authority to interface with district-level administration, school staff, students, parents, and the press.

In addition, the skills already associated with these positions means that the person will not require additional training before assuming the leadership role of the IAQ Coordinator.

In a few situations, it may become necessary to share the responsibilities of the IAQ Coordinator by having a Co-Coordinator, or by delegating many of the administrative items to a committee, such as an existing health and safety committee. The committee could also be composed of selected individuals from the community, such as local environmental or health department staff, parents, and volunteers from local business who have special skills, such as commercial building engineers.

Independent of who is acting as the team leader, it is fundamentally important that on a school-by-school basis, the staff and students have the opportunity to learn about the basics of indoor air quality (*IAQ Backgrounder*) so that their daily decisions and activities (IAQ Checklists) will not unnecessarily cause indoor air problems.

Team Member Action Packets

The Action Packets are designed to help team members:

- understand the importance of good indoor air quality (IAQ)
- understand basic concepts of IAQ
- identify and solve basic IAQ problems
- prevent future problems

The 8 Action Packets in this kit will provide the most benefit when applied in conjunction with the IAQ Management Plan, as outlined in Section 6.

The IAQ Team

The Action Packets provide detailed guidance for each person whose activities and decisions affect the quality of air within the school. These people comprise a team. This team, which is led by the IAQ Coordinator, includes nine distinct groups:

Teachers play a strong role because their decisions and activities can affect the sources of pollutants and levels of ventilation within their room. Some teachers, such as art, science, vocational and industrial arts, and home economics teachers, have unique pollutant sources and ventilation equipment to manage.

Administrative Staff encompasses all administrative and support staff. The staff has control over unique pollutant sources such as printing and kitchen areas, and often controls the operation of the ventilation equipment in their areas.

Facility Operators are the people who have direct technical responsibility for operating and servicing the heating, cooling, and ventilation systems within the school. The role of the facility operator is crucial in preventing and solving IAQ problems.

Custodians and their responsibilities vary widely among school districts. The Building Maintenance Checklist focuses on the housekeeping activities within the school.

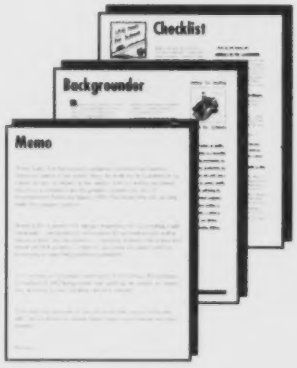
Health Officers sometimes called school nurses, can be helpful by monitoring and recognizing trends in reported illnesses that may give early warning of IAQ problems.

School Boards can provide the resources and authority necessary to implement an IAQ management plan, as outlined in Section 6, and for solving any IAQ problems which may arise, as outlined in Section 12.

Contract Service Providers need to be informed and active members of the IAQ team because their activities can have a direct and substantial impact on the quality of air within your school. Examples of these activities include pesticide application, renovation work such as re-roofing, and maintenance of ventilation equipment and air filters.

Students and Parents are the primary customers and constituents of your school. Students and parents can assist in maintaining good IAQ by understanding and applying basic IAQ principles, such as good personal hygiene.

Local News Media can be helpful by providing educational information to school constituents about IAQ in schools, and can help instill a positive image for your school when the school is taking affirmative steps to prevent IAQ problems. In addition, an unin-



Action Packet

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formed or improperly informed media can result in negative press during an IAQ emergency. The media should not have a direct link to all members of the team. It is recommended that the designated spokesperson, typically the IAQ Coordinator, thoroughly understand the guidance in **Section 8** before communicating with the local news media.

Action Packets Outline

The Action Packets are designed to be useful during the three basic modes of improving your school's IAQ: developing a profile of your school's current indoor air quality, preventing IAQ problems, and solving any IAQ problems which may arise. The Action Packets are comprised of three basic components:

School Memo. For school staff, the memo or letter carries the school administration's request that team members perform the activities as provided in their individual Action Packets. For the school board, contract service providers, local news media, and students and parents, the memo notifies them that the school has undertaken an IAQ management program, and presents the IAQ Backgrounder. Behind the IAQ Coordinator's Forms tab of the kit are four sample memos which can be adapted to your needs.

IAQ Backgrounder. This generic backgrounder will provide all team members with a summary of important issues regarding indoor air quality. Issues included are: what is IAQ, why is IAQ important, basic problems and control methods, the team approach, and communications. Graphics are included to assist in understanding the issues.

IAQ Checklists. The IAQ Checklists provide detailed, yet usually simple, IAQ activities for each team member. These activities are based on the unique functions and locations of teachers, administrative staff, facility operators, custodians, health officers, and contract service providers (e.g., roofers). Each activity deals with a specific pollutant source or ventilation issue. A Checklists Log is provided to assist in summarizing the data from the returned Checklists. The Ventilation Checklist also includes a Ventilation Log for ease of recording the status of each ventilation unit.

Understanding IAQ Problems

Over the past several decades, our exposure to indoor air pollutants has increased due to a variety of factors, including the construction of more tightly sealed buildings, reduced ventilation rates to save energy, the use of synthetic building materials and furnishings, and the use of personal care products, pesticides, and housekeeping supplies. In addition, our activities and decisions, such as deferring maintenance to "save" money, can lead to problems from sources and ventilation.

The indoor environment in any building is a result of the interactions among the site, climate, building structure and mechanical systems (as originally designed and later modified), construction techniques, contaminant sources (what is outside, inside, and part of the building), and building occupants. This section contains a discussion on how these elements can cause IAQ problems, and **Section 12** (*Solving IAQ Problems*) provides solutions. These elements are grouped into four categories:

Sources: there is a source (or sources) of pollution or discomfort indoors, outdoors, or within the mechanical system of the building.

HVAC System: the heating, ventilating, and air conditioning (HVAC) system is not able to control air pollutant levels and/or ensure thermal comfort.

Pathways: one or more pathways connect the pollutant source to the occupants and a driving force exists to move pollutants along the pathway(s).

Occupants: occupant activities have direct impacts on sources, the HVAC system, pathways, and driving forces; and occupants can be carriers of communicable diseases and allergens such as pet dander.

Sources of Indoor Air Pollutants

Indoor air pollutants can originate within the building or be drawn in from outdoors. If pollutant sources are not controlled, IAQ problems can arise, even if the HVAC system is properly designed, operated, and maintained. Air contaminants consist of particles, dust, fibers, bioaerosols, and gases or vapors. It may be helpful to think of air pollutant sources as fitting into one of the categories in the table on the following page, *Typical Sources of Indoor Air Pollutants*. The examples given for each category are not intended to be a complete list. **Appendix E** contains a list of specific air pollutants, with descriptions, sources, and control measures.

In addition to the number of potential pollutants, another complicating factor is that indoor air pollutant concentration levels can vary by time and location within the school building, or even a single classroom. Pollutants can be emitted from point sources, such as from science storerooms, or from area sources, such as newly painted surfaces. Also, pollutants can vary with time, such as only when floor stripping is done, or continuously such as fungi growing in the HVAC system.

Indoor air often contains a variety of contaminants at concentrations that are well below any standards or guidelines for occupational exposure. Given our present knowledge, it is often difficult to relate complaints of specific health effects to exposures to specific pollutant concentrations, especially since the significant exposures may be to low levels of pollutant mixtures.

Interaction of Sources, HVAC Systems, Pathways, and Occupants

If independently evaluated, a minor roof leak and a dirty classroom carpet might not cause much concern, but if the water from the roof leak reaches the carpet, the water can wet the dirt in the carpet and the microscopic fungi that have been dormant in the carpet. The fungi can grow and become a pollutant source that releases spores into the classroom air. The HVAC system acts as a pathway that disperses the spores to other parts of the school, where occupants experience allergic reactions.

Typical Sources of Indoor Air Pollutants

Outside Sources

Polluted Outdoor Air
- pollen, dust, fungal spores
- industrial emissions
- vehicle emissions

Nearby Sources
- loading docks
- odors from dumpsters
- unsanitary debris or building exhausts near outdoor air intakes

Underground Sources
- radon
- pesticides
- leakage from underground storage tanks

Building Equipment

HVAC Equipment
- microbiological growth in drip pans, ductwork, coils, and humidifiers
- improper venting of combustion products
- dust or debris in ductwork

Non-HVAC Equipment
- emissions from office equipment (volatile organic compounds, ozone)
- emissions from shops, labs, cleaning processes

Components/Furnishings

Components
- microbiological growth on soiled or water-damaged materials
- dry traps that allow the passage of sewer gas
- materials containing volatile organic compounds, inorganic compounds, or damaged asbestos
- materials that produce particles (dust)

Furnishings
- emissions from new furnishings and floorings
- microbiological growth on or in soiled or water-damaged furnishings

Other Indoor Sources
- science laboratories
- vocational arts areas
- copy/print areas
- food prep areas
- smoking lounges
- cleaning materials
- emissions from trash
- pesticides
- odors and volatile organic compounds from paint, caulk, adhesives
- occupants with communicable diseases
- dry-erase markers and similar pens
- insects & other pests
- personal care products

HVAC System Design and Operation

The HVAC system includes all heating, cooling, and ventilating equipment serving a school: boilers or furnaces, chillers, cooling towers, air handling units, exhaust fans, ductwork, and filters. A properly designed and functioning HVAC system:

- controls temperature and relative humidity to provide thermal comfort
- distributes adequate amounts of outdoor air to meet ventilation needs of school occupants
- isolates and removes odors and other contaminants through pressure control, filtration, and exhaust fans

Not all HVAC systems are designed to accomplish all of these functions. Some buildings rely only on natural ventilation. Others lack mechanical cooling equipment, and many function with little or no humidity control. The features of the HVAC system in a given building will depend on:

- age of the design
- climate
- building codes in effect at the time of the design
- budget for the project
- designers' and school districts' individual preferences
- subsequent modifications

Description of HVAC Systems

Two of the most common HVAC designs used in schools are central air handling systems and unit ventilators. Both can perform the same HVAC functions of heating, ventilating, and air-conditioning, but the central air handling unit serves multiple rooms while the unit ventilator serves a single room. With central air handling units it is important that all rooms served by the central unit have similar thermal and ventilation requirements. If these requirements differ signifi-

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cantly, some rooms may be too hot, too cold, or underventilated, while others are comfortable and adequately ventilated.

Most air handling units distribute a mixture of outdoor air and recirculated indoor air. HVAC designs may also include units that introduce 100% outdoor air or that simply recirculate indoor air within the building. Uncontrolled quantities of outdoor air enter buildings by leakage through windows, doors, and gaps in the building exterior. Thermal comfort and ventilation needs are met by supplying "conditioned" air, which is a mixture of outdoor and recirculated air that has been filtered, heated or cooled, and sometimes humidified or dehumidified. The basic components for a central air handling unit and a unit ventilator are shown in the *IAQ Backgrounder*.

Thermal Comfort

A number of variables interact to determine whether people are comfortable with the temperature and relative humidity of the indoor air. The amount of clothing, activity level, age, and physiology of people in schools vary widely, so the thermal comfort requirements vary for each individual. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 55-1992 describes the temperature and humidity ranges that are comfortable for 80% of people engaged in largely sedentary activities. That information is summarized in the chart below. The ASHRAE standard assumes "normal" indoor clothing. Added layers of clothing reduce the rate of heat loss.

Uniformity of temperature is important to comfort. Rooms that share a common heating and cooling system controlled by a single thermostat may be at different temperatures.

Temperature stratification is a common problem caused by convection, the tendency of light, warm air to rise, and heavier, cooler air to sink. If air is not properly mixed by the ventilation system, the temperature near the ceiling can be several degrees warmer or cooler than near the floor, where young children spend much of their time. Even if air is properly mixed, uninsulated floors over unheated spaces can create discomfort in some climate zones. Large fluctuations of indoor temperature can also occur when thermostats have a wide "dead band" (a temperature range in which neither heating or cooling takes place).

Radiant heat transfer may cause people located near very hot or very cold surfaces to be uncomfortable even though the thermostat setting and the measured air temperature are within the comfort range. Schools with large window areas sometimes have acute problems of discomfort due to radiant heat gains and losses, with the locations of complaints shifting during the day as the sun angle changes. Poorly insulated walls can also produce a flow of naturally-convecting air, leading to complaints of drafti-

All schools need ventilation, which is the process of supplying outdoor air to the occupied areas within the school.

Recommended Ranges of Temperature and Relative Humidity

Relative Humidity	Winter Temperature	Summer Temperature
30%	68.5°F - 75.5°F	74.0°F - 80.0°F
40%	68.0°F - 75.0°F	73.5°F - 80.0°F
50%	68.0°F - 74.5°F	73.0°F - 79.0°F
60%	67.5°F - 74.0°F	73.0°F - 78.5°F

Recommendations apply for persons clothed in typical summer and winter clothing, at light, mainly sedentary activity.

Source: Adapted from ASHRAE Standard 55-1992, Thermal Environmental Conditions for Human Occupancy

ness. Closing curtains reduces heating from direct sunlight and reduces occupant exposure to hot or cold window surfaces.

Large schools may have interior ("core") spaces in which year round cooling is required to compensate for heat generated by occupants, office equipment, and lighting, while perimeter rooms may require heating or cooling depending on outdoor conditions.

Humidity is a factor in thermal comfort. Raising relative humidity reduces a person's ability to lose heat through perspiration and evaporation, so that the effect is similar to raising the temperature. Humidity extremes can also create other IAQ problems. Excessively high or low relative humidities can produce discomfort, high relative humidities can promote the growth of mold and mildew, and low relative humidities can accelerate the release of spores into the air. (See **Appendix H**.)

Ventilation For Occupant Needs

All schools need ventilation, which is the process of supplying outdoor air to the occupied areas in the school. As outdoor air is drawn into the school, indoor air is exhausted by fans or allowed to escape through openings, thus removing indoor air pollutants. Often, this exhaust air is taken from areas that produce air pollutants such as restrooms, kitchens, science-storage closets, and fume hoods.

Modern schools generally use mechanical ventilation systems to introduce outdoor air during occupied periods, but some schools use only natural ventilation or exhaust fans to remove odors and contaminants. In naturally ventilated buildings, unacceptable indoor air quality is particularly likely when occupants keep the windows closed because of extreme hot or cold outdoor temperatures. Even when windows and doors are open, under ventilation is likely when air movement forces are weakest, such as when there is little wind, or when there is little temperature difference between inside and outside (stack effect).

The amount of outdoor air considered adequate for proper ventilation has varied substantially over time. Because updating building codes often takes several years, the building code, if any, that was in force when your school HVAC system was designed may well have required a lower amount of ventilation than what is currently considered adequate. ASHRAE ventilation standards are used as the basis for most building ventilation codes. A table of outdoor air quantities in schools as recommended by ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality, is shown to the left. Please note that this is a limited portion of the Standard, and that the quantities listed are in units of CFM/person, which is cubic feet per minute of outdoor air for each person in the area served by that ventilation system.

Selected Outdoor Air Ventilation Recommendations (Minimum)

Application	CFM per Person
Classroom	15
Music Rooms	15
Libraries	15
Auditoriums	15
Spectator Sport Areas	15
Playing Floors	20
Office Space	20
Conference Rooms	20
Smoking Lounges	60
Cafeteria	20
Kitchen (cooking)	15

Source: ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality

Pollutant Pathways and Driving Forces

Airflow patterns in buildings result from the combined action of mechanical ventilation systems, human activity, and natural forces. Differences in air pressure created by these forces move airborne pollutants from areas of higher pressure to areas of lower pressure through any available openings. An inflated balloon is an example of this driving force. As long as the opening to the balloon is kept shut, no air will flow, but when open, air will move from inside (area of higher pres-

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sure) to the outside (area of lower pressure). Even if the opening is small, air will move until the pressures inside and outside are equal.

If present, the HVAC ducts are generally the predominant pathway and driving force for air movement in buildings. However, all of a building's components (walls, ceilings, floors, doors, windows, HVAC equipment, and occupants) interact to affect how air movement distributes pollutants within a building.

For example, as air moves from supply outlets to return inlets, it is diverted or obstructed by walls and furnishings, and redirected by openings that provide pathways for air movement. On a localized basis, the movements of people have a major impact on the movement of pollutants. Some of the pathways change as doors and windows open and close. It is useful to think of the entire building — the rooms with connecting corridors and utility passageways between them — as part of the air distribution system.

Air movement can transfer emissions from the pollutant source:

- into adjacent rooms or spaces that are under lower pressure
- into other spaces through HVAC system ducts
- from lower to upper levels in multi-story schools
- transport of pollutants into the building through either infiltration of outdoor air or reentry of exhaust air
- to various points within the room

Natural forces exert an important influence on air movement between a school's interior and exterior. Both the stack effect and wind can overpower a building's HVAC system and disrupt air circulation and ventilation, especially if the school envelope (walls, ceiling, windows, etc.) is leaky.

Stack effect is the pressure-driven airflow produced by convection, the tendency of warm air to rise. Stack effect exists whenever there is an indoor-outdoor temperature difference, and the effect becomes stronger as the temperature difference increases. Multi-story schools are more affected than single-story schools. As heated air escapes from upper levels, indoor air moves from lower to upper levels, and outdoor air is drawn into the lower levels to replace the air that has escaped. Stack effect can transport contaminants between floors by way of stairwells, elevator shafts, utility chases, and other openings.

Wind effects are transient, creating local areas of high pressure (on the windward side) and low pressure (on the leeward side) of buildings. Depending on the size and location of leakage openings in the building exterior, wind can affect the pressure relationships within and between rooms. Entry of outdoor air contaminants may be intermittent or variable, occurring only when the wind blows from the direction of the pollutant source.

Most public and commercial buildings are designed to be positively pressurized, so that unconditioned air does not enter through openings in the building envelope causing discomfort or air quality problems. The interaction between pollutant pathways and intermittent or variable driving forces can lead to a single source causing IAQ complaints in an area of the school that is distant from the pollutant source.

Building Occupants

The term "building occupants" is generally used in this document to describe the staff, students, and other people who spend extended time peri-

ods in the school. Some occupants may be particularly susceptible to the effects of indoor air contaminants:

- allergic or asthmatic individuals
- people who may be sensitive to chemicals
- people with respiratory disease
- people whose immune systems are suppressed due to chemotherapy, radiation therapy, disease, or other causes
- contact lens wearers

Other groups are particularly vulnerable to exposures of certain pollutants or pollutant mixtures. For example:

- people with heart disease may be more affected by exposure to carbon monoxide than healthy individuals
- children exposed to environmental tobacco smoke are at higher risk for respiratory illnesses
- people exposed to significant levels of nitrogen dioxide are at higher risk for respiratory infections

Some occupants may be particularly susceptible to the effects of indoor air contaminants.

Because of varying sensitivity to airborne chemicals and irritants, individuals with heightened sensitivities may react to a particular IAQ problem while surrounding occupants do not display ill effects. Symptoms that are limited to only one or a few persons can also occur when only their area contains the airborne pollutant. In other cases, complaints may be widespread. In addition to different degrees of reaction, an indoor air pollutant or problem can trigger different reactions in different people.

The effects of IAQ problems are often non-specific symptoms rather than clearly defined illnesses. Symptoms (which can occur singly or in groups) commonly attributed to IAQ problems include:

- headache, fatigue, and shortness of breath
- sinus congestion, coughing, and sneezing
- eye, nose, throat, and skin irritation
- dizziness and nausea

These symptoms, however, may be caused by other factors, and are not necessarily due to air pollutants.

"Health" and "comfort" are used to describe a spectrum of physical sensations. For example, when the air in a room is slightly too warm for a person's activity, that person may experience mild discomfort. If the temperature rises, discomfort increases and the symptom of fatigue can appear. The person may attribute this fatigue to an unknown air pollutant, rather than to being too warm.

Some complaints by building occupants are based on discomfort. A common IAQ complaint is that "there's a funny smell in here." If occupants think there is an indoor air problem, the slightest odor can trigger concerns over health, even though the cause of that particular odor may not have any effects on health. Environmental stressors such as improper lighting, noise, vibration, poor ergonomics, and psychosocial problems (such as job stress) also can produce symptoms that are similar to those associated with poor air quality.

Sometimes several school occupants become aware of serious health problems (e.g., cancer, miscarriages) over a relatively short time period. Indoor air quality is occasionally blamed for these clusters of health problems, and this can produce tremendous anxiety among school occupants. State or local health departments can provide advice and assistance if clusters are suspected. They may be able to help answer key questions such as whether the apparent cluster is actually unusual and whether the underlying cause could be related to IAQ.

What Is an IAQ Management Plan?

The IAQ Management Plan as presented in this guidance is a set of flexible and specific activities for preventing and resolving IAQ problems. The goals of the IAQ Management Plan as outlined in this document are:

1. fix any existing IAQ problems
2. instill an IAQ awareness that leads to preventive actions
3. resolve IAQ complaints and incidents as they occur

How the IAQ Management Plan Works

This kit provides the activities and information needed to prevent and resolve most IAQ problems, and provides checklists to help coordinate the activities. As the IAQ Coordinator, you provide the leadership to manage these activities. The delegation of activities to the IAQ team members (primarily school staff) helps ensure that people in the school understand their role in preventing and solving IAQ problems. Because no one person is overly burdened, the program is more likely to get started and succeed.

The IAQ Management Plan can be used as presented, or tailored to the specific needs of your school. Because the organizational and physical structures of schools vary, the IAQ Coordinator may choose to make modifications to this recommended process. For example, the IAQ Coordinator may modify some of the steps in the IAQ Management Plan, or may give the *IAQ Backgrounder* and *Teacher's Checklist* to the teachers for their awareness, but may request that some other staff member perform the actual activities for each teacher. Although the administrative process of who and when is designed to be flexible according to your needs, it is important that all of the individual activities be completed. For additional information on how this kit is organized, see Section 1.

Where to Start

A step-by-step process for activating and implementing the IAQ Management Plan are provided in Sections 7 and 8, and checklists to guide and log this process are provided in the IAQ Coordinator's Forms tab of the kit.

Benefits of an IAQ Management Plan

A well-run IAQ management program yields substantial benefits for the school, employees, and students. In addition to the benefits to health and well-being outlined in Section 2, *Why IAQ Is Important to Your School*, the expensive process of investigating and mitigating suspected IAQ problems can be reduced significantly or avoided entirely by employing the plan.

Recommended Approach for Implementing the Plan

Schools IAQ Coordinator	**WHO**	**School Staff and Contract Service Providers**
↓		
Administrative Actions and Team Leading	**WHAT**	**Hands-on Actions Prevention and Problem Solving**
↓		
Use the IAQ Management Plan Checklists	**HOW**	**Use the Action Packets**

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A typical school provides many opportunities for IAQ problems to develop. Schools contain a variety of special use areas such as kitchens, locker rooms, science laboratories, technology education rooms, darkrooms, art rooms, and cleaning storage areas, each with pollutant sources that can cause discomfort and health problems. Under detailed inspection, most schools will reveal some inadequacies of design, construction, operation, and maintenance.

Prevention Saves

If minor problems are allowed to develop unchecked into a serious IAQ problem, a variety of deficiencies may be identified, but it often cannot be determined which one — if any — caused the problem. As a result, schools can be confronted with an expensive list of potential explanations of their problem. The crisis atmosphere surrounding a serious IAQ problem creates pressure to remedy every deficiency immediately instead of establishing a prioritized approach to IAQ improvement. By contrast, many of the preventive measures recommended in this guidance can be accomplished with in-house effort, following a schedule that reflects your resources.

Significant IAQ problems often arise from combinations of "normal" defects, rather than from exotic or unique circumstances:

- A school is not getting enough outdoor air because a fan belt is broken or slipping *and* a seldom used drain trap drys out, resulting in sewer gases being drawn into the school
- The design of the school ceiling/roof allows significant air leakage through unintentional openings *and* stack effect (warm air rising) pushes indoor air out through these openings, which causes radon to be drawn into the school through cracks and utility penetrations in the floor
- A housekeeping product is mixed at double the recommended strength so it "does a better job" *and* the unused mix is placed in an inappropriate container *and* stored in a utility closet that is connected to the return air ductwork, which results in pollutants being distributed to other parts of the school

IAQ problems may occur even in schools where a conscientious effort is being made to avoid such problems. However, schools that can demonstrate ongoing efforts to provide a safe indoor environment are in a strong legal and ethical position if problems do arise. Further considerations for instituting an IAQ Management Plan include:

- quicker and more cost-effective response if problems occur
- greater peace of mind for parents, students, and staff
- physical plant and equipment provide better comfort and efficiency, and last longer
- less crisis intervention which involves upper-level management

Steps to Activate the IAQ Management Plan

To help ensure that the IAQ Management Plan gets off to a good start, the IAQ Coordinator can perform the following 10 steps as presented, or the steps can be tailored to the specific needs of your school. The checklist, *Activating the IAQ Management Plan*, simplifies tracking completion of these steps.

1. **Select an IAQ Coordinator.** This position is critical to the success of the IAQ Management Plan. If an IAQ Coordinator has not already been selected, please refer to Section 3, *Role and Functions of the IAQ Coordinator*, and ensure that the new Coordinator receives a complete copy of this kit.

2. **Become Familiar with This Guidance.** The IAQ Coordinator should read this Guide to become familiar with the IAQ issues in schools, and to have a basic understanding of the IAQ Management Plan process and effective communication.

3. **Gain Top Administrative Support.** The highest levels of school or district administration should be fully committed to implementing the IAQ Management Plan. The top levels of administration have the authority to ensure that the school staff has the proper incentive and resources to carry out the Plan. It may be useful to provide a briefing to the highest levels of school or district administration using information from the *Note to School Officials* (page i), the *IAQ Backgrounder*, and from additional details found in *Why IAQ Is Important to Your School* (Section 2), *What Is an IAQ Management Plan* (Section 6), and *Effective Communication* (Section 9). Most activities in this Plan have specifically been designed to have little or no impact on the school budget and time resources of school staff. Three of the ventilation system activities will require a few tools which your school most likely will need to purchase, rent, or share. See Appendix C, *Basic Measurement Equipment*, for information.

4. **Obtain Information on Radon.** Radon is a colorless, odorless, and tasteless radioactive gas that occurs naturally in almost all soil and rock. Radon can enter schools through cracks or other openings in their foundations. Radon's decay products can cause lung cancer, and radon is estimated to be second only to smoking as a cause of lung cancer in America. EPA recommends that all schools test for the presence of radon, and provides free guidance on how to perform testing. For information on how to test for radon, and how to reduce radon within your school, see Appendix G, *Radon* and Appendix I, *Resources*.

5. **Obtain Information on Integrated Pest Management.** Several of the activities in the Checklists affect the availability of food and water for pests, which may reduce the number of pests within your school. In addition, EPA recommends that schools use Integrated Pest Management (IPM). IPM is an effective and environmentally sensitive approach to pest management that utilizes a combination of common-sense practices. IPM can reduce the use of chemicals and provide economical and effective pest

To get information from EPA on radon, integrated pest management, and lead, fill out the InfoCard at the back of this Guide and return it to EPA.

suppression. To obtain a copy of Pest Control in the School Environment: Adopting Integrated Pest Management (EPA 735-F-93-012), contact the appropriate office as noted in **Appendix I**, *Resources*.

6. **Obtain Information on Lead.** Children and pregnant women especially should not be exposed to lead dust particles during renovation or repair of surfaces that are painted with lead-based paint. Lead poisoning can affect children's developing nervous systems, causing reduced IQ and learning disabilities. Guidelines for proper removal are available from OSHA (see **Appendix I**).

7. **Establish an IAQ Checklist Interval.** To help maintain a high level of indoor air quality, it is recommended that the *IAQ Coordinator's Checklist* be completed at least once, and preferably twice, each year. Completing the Checklist more than once each year is desirable, because the additional checkups will catch any new and potential IAQ problems. Since many complaints occur at the start of the new school year, completing the IAQ Coordinator's Checklist shortly before school begins would reduce these complaints. Midway through the school year, for example during Christmas break, could be an appropriate time for the second checkup.

8. **Establish a Plan for Emergency Response.** Acute IAQ problems such as a chemical spill, unintentional shutdown of ventilation systems, and other events such as a flooded carpet will require some form of immediate response. Preparing for such events now will help ensure that timely and cost-effective actions result. Preparations may include developing a cooperative agreement or contract with a health and safety agency or private concern to assist with acute IAQ problems that are beyond the capabilities of your team (see **Appendix A**, *Hiring Professional Assistance*). Proper preparation can also mean having the appropriate equipment on hand, for example the equipment needed to immediately clean and dry wet carpets, or having a pre-established agreement with a professional cleaning firm that can provide immediate service on a 24-hour, 7-day-a-week basis.

9. **Inform Appropriate Committees and Groups.** Some of the actions that result from implementing this guidance may need to be coordinated with specific school committees such as a school or school district health and safety committee, or groups such as the local PTA. It may be useful to provide a briefing to these committees and groups that is similar to the briefing in Step 3 above.

10. **Establish IAQ Policies as Needed.** Some activities that affect the quality of air within schools may require clearly written policies from top management to ensure that all school occupants understand how they should or should not perform certain activities. Inappropriate activities include smoking in improperly ventilated areas, pest control by individual occupants, adjustment of ventilation systems by untrained individuals, and maintenance activities such as painting during school hours or by using paints that have lead or high emissions of indoor air pollutants. Sample IAQ policies are provided in **Appendix D**.

The IAQ Management Plan

The IAQ Management Plan involves implementing the following 19 steps on a periodic basis, at least once each year. The IAQ Coordinator can perform the steps as presented, or the steps can be tailored to the specific needs of your school. The steps are grouped into three categories: Assess Current Status, Perform Repairs and Upgrades, and Final Steps. Steps 5-7 can begin at the same time as Step 2. A checklist that simplifies tracking completion of these steps is found in the IAQ Coordinator's Forms tab of the kit.

Complete the Checklist, *Activating the IAQ Management Plan*, before applying the *IAQ Coordinator's Checklist*.

Assess Current Status

1. **Start the Checklists Log.** This log, found in the IAQ Coordinator's Forms section, is used to list all the people who will receive an Action Packet. A unique Action Packet is provided for each specific group of people within the school (i.e., teachers, administrative staff, facility operators, custodians, health officers, contract service providers, and others). The log is also used to keep track of which IAQ Checklists have been returned, and what unresolved IAQ problems, if any, have been identified. **Section 4,** *Team Member Action Packets*, provides details on who comprises the IAQ Team, descriptions of the Action Packet components, and which Action Packet each team member should receive.

2. **Activate the IAQ Team by Distributing the Action Packets.** Copies of the appropriate Action Packets should be provided to each of the team members as listed on the Checklists Log (Step 1). Each Action Packet contains a cover memo, an *IAQ Backgrounder*, and a Checklist. The Action Packets for parents and local media contain only the memo and *IAQ Backgrounder*. Sample memos are located in the IAQ Coordinator's Forms section. You may wish to introduce the Action Packets and the IAQ Management Plan during a meeting of the school faculty and staff.

3. **Receive and Summarize the IAQ Checklists.** By the closing date noted in the cover memo, all Checklists should be returned to you. You should follow up until all Checklists have been completed and returned, then review the information on the Checklists and transfer pertinent data to the Checklists Log. Make a list of irregularities for review during the walkthrough inspection.

4. **Perform a Walkthrough Inspection.** Based on the new perspective you have gained from the information in this kit, and from the summary of the Checklists, perform a walkthrough inspection of the school. This is not intended to be an intensive and detailed inspection, but rather a quick overview of the conditions that affect the quality of air within your school. You may wish to have someone who is familiar with the operation of the building, such as a facility operator or custodian, assist you during the inspection.

During your walkthrough inspection, you can learn a lot by using your sense of sight, smell, feeling, and hearing to gain information on factors which affect indoor air quality.

You can learn a lot by using your sense of sight, smell, feeling, and hearing to gain information on factors which affect indoor air quality.

- ***Observe*** the general level of cleanliness in classrooms and mechanical rooms. Look for pollutant sources such as mold, improperly stored chemicals, or excessively dirty air filters and ducts, and look for blocked airflows such as those caused by books or papers on top of unit ventilators or plywood covering outdoor air intakes.
- ***Smell*** for unique or objectionable odors as you move from room to room.
- ***Feel*** for uncomfortable air temperatures, drafts, and high or low humidity, and feel for air flowing into and out of grilles and air vents.
- ***Listen*** to the concerns of school occupants regarding IAQ. Do they provide clues to problems such as using their own pest spray to control pests, or turning off the unit ventilator because it is too noisy during class-time? Do you hear unusual equipment noises which may indicate potential problems, and do you hear air blowing out of supply vents?

Also, perform a walkthrough inspection in all special-use areas, such as the cafeteria, art rooms, industrial arts areas, and science laboratories. For information on smoking lounges, see Appendix F.

5. **Assess Radon Status.** Consider the following questions regarding your current radon status (for specific considerations see the EPA guidance document on radon):

- Has testing for radon been completed?
- If needed, has a radon mitigation system(s) been installed?
- Are all radon mitigation systems operating properly?

6. **Assess Pest Control Program.** Consider the following questions regarding your current pest control program (for specific considerations see the EPA guidance document on Integrated Pest Management, IPM):

- Are IPM principles being applied in all areas?
- Are staff using pest control chemicals in accordance with instructions?
- Are only spot-treatments of pesticides used to control obviously infested areas, in place of widespread, indiscriminate application of pesticides?

7. **Assess Lead Status.** Consider the following questions regarding your current lead status (for specific considerations see the EPA guidance document on lead):

- Has lead contamination been assessed in your school?
- Is a lead control or removal program in place?
- Will any upcoming renovation work affect surfaces painted with lead-based paint?

8. **Identify Recent Changes that Affect IAQ.** Consider whether any recent changes to the school building, around the building, to the school schedule or activities, or to occupants, has had an impact on IAQ. Examples include:

- *Has flooding occurred?* Look and smell for microbiological growth and an increase in IAQ complaints in flooded areas.
- *Have night or weekend classes started?* Check time clock(s) setting on the ventilation system(s) for these class areas.
- *Have new staff been added?* Give them an Action Packet.

Perform Repairs and Upgrades

9. Set Repair and Upgrade Priorities. In all likelihood, the Checklists (Step 3) and your walkthrough inspection (Step 4) identified some IAQ problems which have not been corrected. Based on your knowledge of the problem, and your resources of school staff and funding, set repair and upgrade priorities based on your specific needs, and make a to-do list. Include any unresolved problems from previous IAQ Coordinator's Checklists.

Section 12 provides some ideas on what may be involved in solving the problems ("Developing Solutions" and "Solutions for Other Complaints"). In addition, Section 12 also provides basic criteria for determining the practicality of the proposed solutions (*"Evaluating Solutions"*).

10. Gain Consensus and Approvals. Because of the potential complexities involved in setting priorities for repairs and upgrades (Step 9 above), and for committing school resources, an agreement from top school management and appropriate committees will probably be necessary.

11. Distribute Status Report. Keep school occupants and constituents informed about the general status of IAQ in your school according to the principles of effective communication in Section 9.

12. Perform Repairs and Upgrades. Ensure that the priorities set in Step 9 are met as the repairs and upgrades are being performed (see Section 12, *"Evaluating Solutions"*).

13. Conduct Follow-up Inspections. Determine if the repairs and upgrades were performed according to plan or specifications, and determine if the intended results were obtained (see Section 12, *Solving IAQ Problems*).

Final Steps

14. Develop a Schedule of IAQ Events. It would be very helpful for you, as the IAQ Coordinator, to develop and maintain a schedule of events which may affect IAQ. This could be a separate schedule, but would probably work best if the IAQ events were noted directly on your personal schedule. Following are some examples of IAQ events to note:

- Establish a date for the next round of implementing the IAQ Coordinator's Checklist (see Section 7, Step 7, for details).
- If your school is in a humid climate and will be closed-up over the summer, set weekly dates to check for mold growth (sight and smell). Take measures, such as cycling the cooling system, to keep relative humidity below 60% as needed.
- Will there be any renovation or new construction during school time, school breaks, or the summer? If so, mark your schedule with enough lead time so that you can provide Action Packets or other information to the people performing the work.
- Will new school staff be added? If so, mark your schedule to give them appropriate Action Packets so that they can become part of the IAQ team.

15. Assess Problem-Solving Performance. Assess recent problem-solving performance and determine if changes need to be made in your ability to:

Develop and maintain a schedule of events which may affect IAQ, such as building renovation, major repairs, summer shutdown, and new staff.

It is important that everyone affected — students, parents, teachers, staff, and administration — receive a report of IAQ issues.

- respond to IAQ complaints and incidents quickly
- solve IAQ problems, preferably permanently
- communicate in a way that prevents or reduces the concerns of school occupants and constituents during an IAQ problem or crisis

For information on resolving IAQ complaints and incidents, and how to communicate during IAQ problems, use the guidance in **Sections 10 through 13**.

16. Establish and Update IAQ Policies. Based on what you have learned during this round of implementing the IAQ Management Plan, does an IAQ policy need to be established to prevent IAQ problems from recurring? Address any existing IAQ policies which are not being properly followed. For information on establishing IAQ policies, see **Appendix D**.

17. Distribute Summary Report. It is important that school occupants and constituents, as well as the school administration, receive a report of IAQ issues from this round of the IAQ Management Plan. The Plan is not complete until others know at least the basics of what you know about the status of IAQ in your school. For additional guidance on what to include in the report, see **Sections 9 and 13**.

When reporting to school or district administration, it may be desirable to provide indicators of how successful the IAQ Management Plan has been to date. Indicators may include:

- all IAQ Checklists completed and returned
- all IAQ problems identified by the Checklists corrected
- fewer IAQ complaints
- establishment of good relations with the local media
- school memo and *IAQ Backgrounder* mailed to all parents

18. Check Contacts List. Ensure that the contact information is still valid, so that assistance can be quickly obtained if needed.

19. File Checklists, Reports, and Notes. For future reference when setting repair priorities or solving persistent problems, and for accountability purposes, it is recommended that all completed paperwork be filed in a readily accessible manner. Files should include:

- Activating the IAQ Management Plan checklist
- IAQ Coordinator's Checklist
- Checklists from team members who received an Action Packet
- Checklists Log
- IAQ Problem Solving Checklist
- Copies of memos, status reports, and final reports
- Copies of communications with school or district administration
- Any personal notes, contracts, or other paperwork as appropriate

Effective Communication

9

Good communication can help prevent indoor air quality problems, and can allay unnecessary fears. Communication can assist school occupants in understanding how their activities affect IAQ, which will enable the occupants to improve their indoor environment through proper choices and actions.

Good communication also involves building rapport with the local media now, before a potentially serious IAQ problem occurs. An informed media that understands your efforts to prevent IAQ problems, and that understands the basics of IAQ in schools, can be an asset instead of a liability during an IAQ crisis.

The following five objectives are important in assuring good communication between you and the school occupants:

1. provide accurate information about factors that are affecting IAQ
2. clarify the responsibilities and activities of the IAQ Coordinator
3. clarify the responsibilities and activities of each occupant
4. notify occupants and parents of planned activities that may affect IAQ
5. employ good listening skills

The Action Packets, forms, and information contained in this kit will assist you in accomplishing the first three objectives. In addition, refer to the list of communication principles on the next page.

The level of communication is often dependent on the severity of the indoor air quality complaint. If the complaint can be resolved quickly and involves a small number of people (e.g., an annoying but harmless odor from an easily identified source), communication can be handled matter-of-factly like other minor problems without risking confusion and bad feeling among school occupants. Communication becomes a more critical issue when there are delays in identifying and resolving the problem and when serious health concerns are involved.

The fourth objective deals with informing occupants and parents before the start of significant planned activities that produce odors or contaminants. If occupants and parents are uninformed, they may become concerned about unknown air contaminants, such as strange odors or excessive levels of dust, and register an IAQ complaint. Examples of planned activities include pest control, painting, roofing, and new flooring. Notification of planned activities can also prevent problems from arising with students and staff with special needs. For example, an asthmatic student may wish to avoid certain areas within a school, or use alternative classrooms, during times when a major renovation project will produce higher levels of dust. A sample notification letter is provided in the model painting policy in **Appendix D**.

Finally, effective communication also involves effective listening. Listening may provide information that helps prevent problems, and it may help defuse negative reactions by occupants if indoor air problems should occur.

If a tense atmosphere exists due to concerns about current IAQ problems, please refer also to Section 13, "Communication When Problem Solving."

Communication Principles

- ***Be honest, frank, and open.*** Once trust and credibility are lost they are almost impossible to regain. If you don't know an answer or are uncertain, say so. Admit mistakes. Get back to people with answers. Discuss data uncertainties, strengths, and weaknesses.
- ***Respect your audience.*** If people are sufficiently motivated, they are quite capable of understanding complex information. However, they may not agree with you. Further, no matter how well you communicate, some people will not be satisfied.
- ***Avoid technical language and jargon.*** Minimize and fully explain any necessary technical language. Use concrete images that communicate on a personal level. People in the community are often more concerned about such issues as credibility, competence, fairness, and compassion than about statistics and details.
- ***Employ your best listening skills.*** Take time to find out what people are thinking, rather than assuming that you already know.
- ***Different audiences require different communication strategies.*** Use mass media for providing information, and interpersonal techniques for changing attitudes.
- ***Involve school employees.*** An informed staff is likely to be a supportive staff.
- ***Involve parents.*** Inform parents about what is being done and why, as well as what will happen if problems are detected.
- ***Involve the school board.*** Encourage board members to observe the process (e.g., taking a walkthrough of the school with the IAQ Coordinator).
- ***Emphasize action.*** Always try to include a discussion of actions that are underway or that can be taken.
- ***Encourage feedback.*** Accentuate the positive, and learn from your mistakes.
- ***The goal is an informed public.*** Strive to produce a public that is involved, interested, reasonable, thoughtful, solution-oriented, and collaborative.
- ***Be prepared for questions.*** Provide background material on complex issues. Avoid public conflicts or disagreements between credible sources.
- ***Be responsive.*** Acknowledge the emotions that people express and respond in words and actions. When in doubt, lean toward sharing more information, not less, or people may think you are hiding something.
- ***Combat rumors with facts.*** For example, set up a chalkboard in the teachers' lounge for recording what is heard. Record rumors as they arise, and add responses. Then pass out copies to the staff.
- ***Tell people what you can and cannot do.*** Promise only what you can do and do what you promise.
- ***Work with the media.*** Be accessible to reporters and respect deadlines. Try to establish long-term relationships of trust with specific editors and reporters. Remember that the media are frequently more interested in politics than in science, more interested in simplicity than complexity, more interested in danger than safety.

Once trust and credibility are lost they are almost impossible to regain.

Resolving IAQ Problems

Resolving indoor air quality (IAQ) problems involves diagnosing the cause, applying practical actions that either reduce emissions from pollutant sources or remove pollutants from the air (e.g., increasing ventilation or air cleaning), or both. Causes for problems with sources can stem from improper material selection or application, from allowing conditions that can increase microbiological contamination and dust accumulation, or from source location. Causes for problems with ventilation stem from improper design, installation, operation, or maintenance of the ventilation system.

This kit provides guidance for most IAQ problems found in schools, and does not require that pollutant measurements be performed and analyzed.

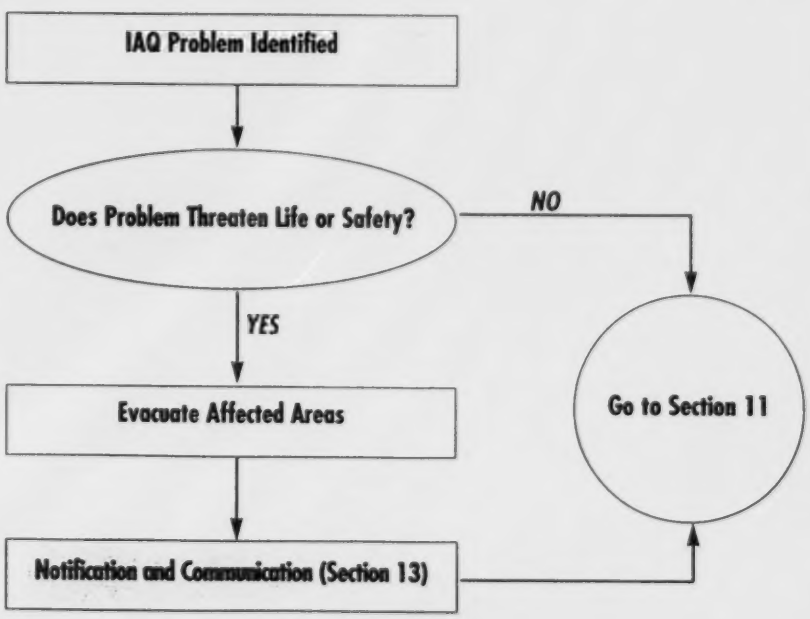
It is important to take reported IAQ problems seriously and respond quickly because:

- IAQ problems can be a serious health threat and can cause acute discomfort (irritation) or asthma attacks
- Addressing an IAQ problem promptly is good policy. Parents are sensitive to unnecessary delays in resolving problems that affect their children. Staff have enough burdens without experiencing frustration over unresolved problems, and unaddressed problems invariably lead to greater complaints
- Diagnosing a problem is easier immediately after the complaint(s) has been received. The source of the problem may be intermittent and the symptoms may come and go. Also, the complainant's memory of events is best immediately after the problem occurs.

In some cases, people may believe that they are being adversely affected by the indoor air, but the basis for their perception may be some other form of stressor not directly related to indoor air quality. Section 12 discusses some of these stressors such as glare, noise, and psychosocial factors.

Is This an Emergency?

The first decision that must be made in dealing with an IAQ problem is whether the problem requires an emergency response. Most IAQ problems can be diagnosed and resolved on a short-term, and in some cases even a long-term, basis. But some IAQ incidents require immediate response — high carbon monoxide levels or certain toxic chemical spills will require evacuation of all affected areas in the school, and biological contamination such as



For most problems, a team of in-house staff . . . can be pulled together to solve a problem.

Legionella may require a similar response. In recent years, large outbreaks of influenza have caused entire schools and districts to temporarily cease operation. Some schools and districts may already have established policies on what constitutes a life and safety emergency. Local and State health departments can also be helpful in defining life and safety threatening emergencies.

If this is an emergency situation, in addition to immediate action to protect life and health, it is vital that the school administration, parents of students, and appropriate authorities be notified of the situation in a carefully coordinated manner. You must also be prepared to quickly and properly deal with questions from local media. Review the guidance in **Section 13**, *Communication When Problem Solving*, to assist in managing the issues of notification and communication.

Who Will Solve the Problem?

For most problems, a team of in-house staff, with an appropriate range of skills, can be pulled together to solve a problem. The use of in-house staff builds IAQ knowledge and skills that will be helpful in minimizing and resolving future problems. The Action Packets can teach these skills for typical IAQ problems found in schools. On the other hand, unique or complex IAQ problems may best be handled by professionals who have specialized knowledge, experience, and equipment. Your knowledge of your staff's capabilities will help in deciding whether in-house personnel or outside professionals should be used in responding to the specific IAQ problem.

Regardless of whether it is in-house staff or outside assistance that diagnoses and solves the problem, the IAQ Coordinator remains responsible for managing the problem solving process, and for communicating as needed with all appropriate parties during the process. If an IAQ Coordinator has not been appointed already, please refer to **Section 3**, *Role and Functions of the IAQ Coordinator.*

Diagnosing IAQ Problems

The goal of diagnosing an IAQ problem is to discover the cause of the problem so that an appropriate solution can be implemented. Often, more than one problem will be present, requiring more than one solution. This section presents the Problem Solving Checklist and the IAQ Problem Solving Wheel for diagnosing and solving problems. For best results, it is also important to have good background knowledge of the basics of IAQ as outlined in **Sections 2 and 5.**

The IAQ diagnostic process begins when a complaint is registered or an IAQ problem is identified. Many problems can be simple to diagnose, requiring a basic knowledge of IAQ and some common sense. If the cause (or causes) of the IAQ problem has already been identified, proceed to the solution phase outlined in **Section 12.**

Not all occupant complaints about indoor air quality are caused by poor indoor air. Other factors such as noise, lighting, and job-, family-, or peer-related psychosocial stressors can — individually and in combination — contribute to a perception that the indoor air quality is poor.

How to Diagnose Problems

The Problem Solving Checklist and the IAQ Problem Solving Wheel are your primary tools for solving problems, and will help simplify the process. They serve to lead the investigation in the right direction and offer suggestions for other areas to evaluate.

Start with the Problem Solving Checklist, and enlist the assistance of school staff to answer questions or perform activities posed by the Checklist and the Wheel. Consider that pollutant sources and the ventilation system may act in combination to create an IAQ problem.

If the investigation identifies a potential problem (e.g., you find a blocked vent), remedy the situation to see if the symptoms stop. You may find problems unrelated to the symptoms or a number of potential causes. Resolve as many problems as is feasible and make note of any problems that you intend to fix later.

Once the likely cause of the IAQ problem is identified, or if the solution is readily apparent, refer to **Section 12,** *Solving IAQ Problems*, for information on courses of action.

Spatial and Timing Patterns

As a first step use the spatial pattern (locations) of complaints to try to define the complaint area. School locations where symptoms or discomfort occur define the rooms or zones that should be given particular attention during the investigation. However, the complaint area may need to be revised as the investigation progresses. Pollutant pathways can cause complaints in parts of the school that are far removed from the source of the problems. See the *Spatial Patterns* table on the next page.

After a location or group of locations have been defined, look for patterns in the timing of complaints. The timing of symptoms and complaints can indicate potential causes for the complaints and provide directions for further investigation. Review the data for cyclic patterns of symptoms (e.g., worst during periods of minimum ventilation or when specific sources are most active) that may be related to HVAC system operation or to other activities in and around the school. See the *Timing Patterns* table on the next page.

Spatial Patterns of Complaints	Suggestions
Widespread, no apparent spatial pattern	• Check ventilation and temperature control for entire building • Check outdoor air quality • Review sources that are spread throughout the building (e.g., cleaning materials or microbiological growth inside the ventilation system) • Check for distribution of a source to multiple locations through the ventilation system • Consider explanations other than air contaminants
Localized (e.g., affecting individual rooms, zones, or air handling systems)	• Check ventilation and temperature control within the complaint area • Review pollutant sources affecting the complaint area • Check local HVAC system components that may be acting as sources or distributors of pollutants
Individual(s)	• Check for drafts, radiant heat (gain or loss), and other localized temperature control or ventilation problems near the affected individual(s) • Consider that common background sources may affect only susceptible individuals • Consider the possibility that individual complaints may have different causes that are not necessarily related to the building (particularly if the symptoms differ among the individuals)

Timing Patterns of Complaints	Suggestions
Symptoms begin and/or are worst at the start of the occupied period	• Review HVAC operating cycles. Pollutants from building materials, or from the HVAC system itself, may build up during unoccupied periods
Symptoms worsen over course of occupied period	• Consider that ventilation may not be adequate to handle routine activities or equipment operation within the building, or that temperature is not properly controlled
Intermittent symptoms	• Look for daily, weekly, or seasonal cycles or weather-related patterns, and check linkage to other events in and around the school
Single event of symptoms	• Consider spills, other unrepeated events as sources
Recent onset of symptoms	• Ask staff and occupants to describe recent changes or events (e.g., remodeling, renovation, redecorating, HVAC system adjustments, leaks, or spills)
Symptoms relieved on leaving the school, either immediately, overnight, or (in some cases) after extended periods away from the building	• Consider that the problem may be building-associated, though not necessarily due to air quality. Other stressors (e.g., lighting, noise) may be involved
Symptoms never relieved, even after extended absence from school (e.g., vacations)	• Consider that the problem may not be building-related

Solving IAQ Problems

12

The purpose of this section is to provide an understanding of basic principles in solving IAQ problems. This guidance can be helpful in selecting a mitigation strategy, and in evaluating the practicality and effectiveness of proposals from in-house staff or outside professionals.

Developing Solutions

Selection of a solution is based on the data gathered during diagnostics (**Section 11**). The diagnostics may have determined that the problem was either a real or a perceived IAQ problem, or combination of multiple problems. For each problem that the diagnostics identify, develop a solution using the basic control strategies described below.

There are six basic control methods for lowering concentrations of indoor air pollutants. Often only a slight shift in emphasis or action using these control methods is needed to more effectively control indoor air quality. Specific applications of these basic control strategies can be found in each team member's Checklist.

Source Management includes source removal, source substitution, and source encapsulation. Source management is the most effective control method when it can be practically applied.

- **Source removal** is very effective. However, policies and actions that keep potential pollutants from entering the school are even better at preventing IAQ problems. Other examples of source removal include not allowing buses to idle near outdoor air intakes, not placing garbage in rooms where HVAC equipment is located, and banning smoking within the school.
- **Source substitution** includes actions such as selecting a less toxic art material or interior paint than the products which are currently in use.
- **Source encapsulation** involves placing a barrier around the source so that it releases fewer pollutants into the indoor air.

Local Exhaust is very effective in removing point sources of pollutants before they can disperse into the indoor air by exhausting the contaminated air outside. Well known examples where local exhaust is used include restrooms and kitchens. Other examples include science labs and housekeeping storage rooms, printing and duplicating rooms, and vocational/industrial areas such as welding booths.

Ventilation through use of cleaner (outdoor) air to dilute the polluted (indoor) air that people are breathing. The ventilation system, when properly designed, operated, and maintained, will automatically take care of "normal" amounts of air pollutants. For emergency situations, such as quick removal of toxic fumes, increased ventilation can be useful, but when considering long-term operating costs, employing "dilution as the solution" is best applied after attempts have been made to reduce the source of the pollutant.

Exposure Control includes adjusting the time, amount, and location of use to reduce exposure.

- **Time of use.** Try not to use a pollutant source when the school is occupied. For example, strip and wax floors on Friday after school is dis-

missed, so that the floor products have a chance to off-gas over the weekend, reducing the level of pollutants in the air when the school is reoccupied on Monday.

- **Amount of use.** If less of an air polluting source can be used, then less of it will end up in the air.
- **Location of use.** Move the polluting source as far as possible from occupants, or relocate susceptible occupants.

Air Cleaning primarily involves the filtration of particulates from the air as it passes through the HVAC equipment. Gaseous pollutants can also be removed, but these removal systems must be engineered on a case-by-case basis.

If people are provided information . . . they can act to reduce their personal exposure.

Education of school occupants regarding IAQ is critical. If people are provided information about the sources and effects of pollutants in their control, and about the proper operation of the ventilation system, they can act to reduce their personal exposure.

Some solutions, such as major ventilation modification, may not be practically implemented due to lack of resources, or due to the need for long periods of non-occupancy so that the work can be safely completed. Employ temporary measures to ensure good IAQ in the mean time.

Solutions for Other Complaints

Specific lighting deficiencies or localized sources of noise or vibration can sometimes be readily identified, and remedial action may be fairly straightforward, such as having more or fewer lights, making adjustments for glare, and relocating, replacing, or acoustically insulating a noise or vibration source. Similarly, some causes of ergonomic or psychosocial stress may be apparent even to an untrained observer.

In other cases, where problems may be more subtle or solutions more complex (such as psychogenic illnesses), enlist the services of a qualified professional.

Remedial actions for lighting, noise, and vibration problems might range from modifications of equipment or furnishings to renovation of the building. Ergonomic deficiencies may require furniture or equipment changes or different work practices. The solution to psychosocial problems for school staff may involve new management practices, job redesign, or resolution of underlying labor-management problems.

Evaluating Solutions

To help ensure a successful solution, mitigation efforts should be evaluated at the planning stage by considering the following criteria:

- permanence
- durability
- operating principle
- installation & operating cost
- control capacity
- ability to institutionalize the solution
- conformity with codes

Permanence. Mitigation efforts that create permanent solutions to indoor air problems are clearly superior to those that provide temporary solutions, unless the problems are also temporary. Opening windows or running air handlers on full outdoor air may be suitable mitigation strategies for a temporary problem such as off-gassing of volatile compounds from new furnishings, but are not accept-

able permanent solutions due to increased costs for energy and maintenance. A permanent solution to microbiological contamination involves not only cleaning and disinfection, but also moisture control to prevent regrowth.

Durability. IAQ solutions that are durable are more attractive than approaches that require frequent maintenance or specialized skills. New items of equipment should be quiet, energy-efficient, and durable.

Operating Principle. The most economical and successful solutions to IAQ problems are those in which the operating principle of the correction strategy makes sense and is suited to the problem. If a specific point source of contaminants has been identified, treatment at the source by removal, sealing, or local exhaust is almost always a more appropriate correction strategy than dilution of the contaminant by increased general ventilation. If the IAQ problem is caused by the introduction of outdoor air that contains contaminants, then increasing the outdoor air supply will only make the situation worse, unless the outdoor air being supplied is cleaned.

Installation and Operating Costs. The approach with the lowest initial cost may not be the least expensive over the long run. Long-term economic considerations include: energy costs for equipment operation, increased staff time for maintenance, differential cost of alternative materials and supplies, and higher hourly rates if odor-producing activities such as cleaning must be scheduled for unoccupied periods.

Control Capacity. It is important to select a solution whose size and scope fits the problem. If odors from a special use area such as a kitchen are causing complaints in nearby classrooms, increasing the ventilation rate in the classrooms may not be successful. If mechanical equipment is needed to correct the IAQ problem, it must be powerful enough to accomplish the task. For example, a local exhaust system should be strong enough and close enough to the source so that none of the contaminant moves into other portions of the building.

Ability to Institutionalize the Solution. A solution will be most successful when it is institutionalized as part of normal building operations. Solutions that do not require exotic equipment are more likely to be successful in the long run than approaches that involve unfamiliar concepts or delicately maintained systems. If maintenance or housekeeping procedures or supplies must change as part of the solution, it may be necessary to provide additional training, new inspection checklists, or modified purchasing guidelines. Operating and maintenance schedules for heating, cooling, and ventilation equipment may also need modification.

Conformity with Codes: Any modification to building components or mechanical systems should be designed and installed in conformance with applicable fire, electrical, and other building codes.

A solution will be most successful when it is institutionalized as part of normal building operations.

Evaluating the Effectiveness of Your Solution

Two kinds of indicators can be used to evaluate the success of an effort to correct an indoor air problem:

- reduced complaints
- measurement of the properties of the indoor air

Reduction or elimination of complaints appears to be a clear indication

of success, but that is not necessarily the case. Occupants who realize that their concerns are being heard may temporarily stop reporting discomfort or health symptoms, even if the actual cause of their complaints has not been corrected. On the other hand, lingering complaints may continue after successful mitigation if people have become upset over the handling of the problem. A smaller number of ongoing complaints may indicate that there were multiple IAQ problems and that one or more problems are still unresolved.

Ongoing complaints may indicate that there were multiple IAQ problems and that one or more problems are still unresolved.

Measurements of airflows, ventilation rates, and air distribution patterns can be used to assess the results of control efforts. Airflow measurements taken during the building investigation can identify areas with poor ventilation; later they can be used to evaluate attempts to improve the ventilation rate, distribution, or direction of flow. Studying air distribution patterns will show whether a mitigation strategy has successfully prevented a pollutant from being transported by airflow. While in some cases the measurement of pollutant levels can be used as a means of determining whether indoor air quality has improved, in many cases this may be difficult and/or prohibitively expensive. Concentrations of indoor air pollutants typically vary greatly over time; further, the specific contaminant measured may not be causing the problem. Measurement of a specific pollutant by a professional is appropriate if the problem was limited to that pollutant. For further information on IAQ measurements, see **Appendix C**.

Persistent Problems

Even the best-planned investigations and mitigation actions may not produce a resolution to the problem. You may have made a careful investigation, found one or more apparent causes for the problem, and implemented a control system. Nonetheless, your correction strategy may not have caused a noticeable reduction in the concentration of the contaminant or improvement in ventilation rates or efficiency. Worse, the complaints may persist even though you have been successful at improving ventilation and controlling all of the contaminants you could identify. When you have pursued source control options and have increased ventilation rates and efficiency to the limits of your expertise, you must decide how important it is to pursue the problem further.

If you have made several unsuccessful efforts to control a problem, then it may be advisable to seek outside assistance. The problem may be fairly complex, and it may occur only intermittently or cross the borders that divide traditional fields of knowledge. It is even possible that poor indoor air quality is not the actual cause of the complaints. Bringing in a new perspective at this point can be very effective. **Appendix A** provides guidance on hiring professional indoor air quality assistance.

Communication When Problem Solving

13

When a major, and sometimes even minor, IAQ problem occurs, you can be assured that the school community will learn about it quickly. Without open communication, any IAQ problem can become complicated by anxiety, frustration, and distrust. These complications can increase both the time and money needed to resolve the problem.

Immediate communication is vital, and is easiest if a few strategic steps are taken before an IAQ problem arises. First, ensure that a spokesperson is ready by having a working understanding of the communication guidance found in this section and **Section 9**, and a background knowledge of IAQ as outlined in **Sections 2 and 5**. This person should also have complete access to information as the investigation progresses. Because of these qualifications, the IAQ Coordinator may be a good choice for spokesperson. Second, establish a plan for how you will communicate to the school community. The school community includes all occupants of the school, parents, the school district administration and school board, and the local news media.

Paying attention to communication when solving a problem helps to ensure the support and cooperation of school occupants as the problem is investigated and resolved. The basic, yet important, messages to convey are:

- school administration believes it is important to provide a healthy and safe school
- good IAQ is an essential component of a healthful indoor environment
- complaints about IAQ are taken seriously

When a problem arises, communication should begin immediately. You should not wait until an investigation is nearly completed, or until final data are available, before providing some basic elements of information. Communications, whether in conversations or in writing, should include the following elements in a factual and concise manner:

- the general nature of the problem, if it is known, the types of complaints which have been received, and the locations which are affected
- the administration's policy in regard to providing a healthy and safe environment
- what has been done to date to address the problems or complaints, including the types of information that are being gathered
- what is currently being done, including factors that have been evaluated and found not to be causing or contributing to the problem
- how the school community can help
- attempts that are being made to improve IAQ
- work that remains to be done and the expected schedule for its completion
- the name and telephone number of the IAQ Coordinator, who can be contacted for further information or to register complaints

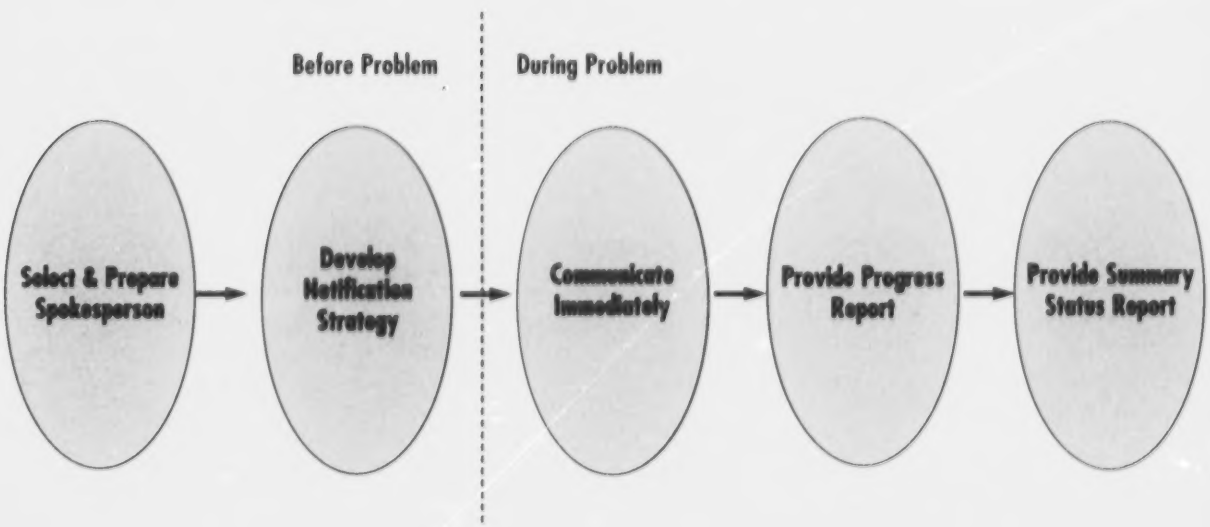
Productive relations will be enhanced if the school community is given basic progress reports during the process of diagnosing and solving problems. It is advisable to explain the nature of investigative activities, so that rumors and suspicions can be countered with

factual information. Notices or memoranda can be posted in general use areas and delivered directly to parents, the school board, and other interested constituents of the school community. Newsletter articles or other established communication channels can also be used to keep the school community up-to-date.

Problems can arise from saying either too little or too much. Premature release of information when data-gathering is still incomplete can produce confusion, frustration, and mistrust at a later date. Similar problems can result from incorrect representation of risk — improperly assuming the worst case, or the best. However, if even simple progress reports are not given, people will think that either nothing is being done, or that something terrible is happening.

Even after the proper mitigation strategy is in place, it may take days or weeks for contaminants to dissipate and symptoms to disappear. If building occupants are informed that their symptoms may persist for some time after solving the problem, the inability to bring instant relief is less likely to be seen as a failure.

Remember to communicate as the final step in problem solving — although you may know that the problem has been solved, the school community may not know, so be sure to provide a summary status report.



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Hiring Professional Assistance

Some IAQ problems are simple to resolve when school personnel understand the building investigation process. Many potential problems will be prevented if staff and students do their part to maintain good indoor air quality. However, a time may come when outside assistance is needed. For example, professional help might be necessary or desirable in the following situations:

- If you suspect that you have a serious building-related illness potentially linked to biological contamination in your building, mistakes or delays could have serious consequences (e.g., health hazards, liability exposure, regulatory sanctions). Contact your local or State Health Department.
- Testing for a public health hazard (such as asbestos, lead, or radon) has identified a problem that requires a prompt response.
- The school administration believes that an independent investigation would be better received or more effectively documented than an in-house investigation.
- Investigation and mitigation efforts by school staff have not relieved an IAQ problem.
- Preliminary findings by staff suggest the need for measurements that require specialized equipment and skills that are not available in-house.

Hiring Professional Help

As you prepare to hire professional services for a building investigation, be aware that indoor air quality is a developing area of knowledge. Most individuals working in IAQ received their primary training in other disciplines. It is important to define the scope of work clearly and discuss any potential consultant's proposed approach to the investigation, including plans for coordinating efforts among team members. The school's representatives must exercise vigilance in overseeing diagnostic activities and corrective action. Performance specifications can help to ensure the desired results. Sample performance specification language is italicized.

Other than for lead and asbestos remediation, there are no Federal regulations covering professional services in the general field of indoor air quality, although some disciplines (e.g., engineers, industrial hygienists) whose practitioners work with IAQ problems have licensing and certification requirements. Individuals and groups that offer services in this evolving field should be questioned closely about their related experience and their proposed approach to your problem. In addition, request and contact references.

Local, State, or Federal government agencies (e.g., education, health, or air pollution agencies) may be able to provide expert assistance or direction in solving IAQ problems. If available government agencies do not have personnel with the appropriate skills to assist in solving your IAQ problem, they may be able to direct you to firms in your area with

experience in indoor air quality work. You may also be able to locate potential consultants by looking in the yellow pages (e.g., under "Engineers," "Environmental Services," "Laboratories – Testing," or "Industrial Hygienists"), by asking other schools for referrals, or by calling IAQ*Info* at 1-800-438-4318. Often, a multi-disciplinary team of professionals is needed to investigate and resolve an IAQ problem. The skills of HVAC engineers and industrial hygienists are typically useful for this type of investigation. Input from other disciplines such as chemistry, architecture, microbiology, or medicine may also be important. If problems other than indoor air quality are involved, experts in lighting, acoustic design, interior design, psychology, or other fields may be helpful in resolving occupant complaints about the indoor environment.

Evaluating Potential Consultants

As with any hiring process, the better you know your own needs, the easier it will be to select individuals or firms to service those needs. The more clearly you can define the project scope, the more likely you are achieve the desired result without paying for unnecessary services.

An investigation strategy based on evaluating building performance can be used to solve a problem without necessarily identifying a particular chemical compound as the cause. The idea of testing the air to learn whether it is "safe" or "unsafe" is very appealing. However, most existing standards for airborne pollutants were developed for industrial settings, where the majority of occupants are usually healthy adult men.

Some state regulations call for the involvement of a professional engineer for any modifications or additions to a school HVAC system. Whether or not this is legally mandated for your school, the professional engineer's knowledge of air handling, conditioning and sequencing strategies will help to design ventilation system modifications without creating other problems. In some situations, proper engineering can save energy while improving indoor air quality. An example of this might be the redesign of outside air handling strategies to improve the performance of an economizer cycle.

These guidelines may be of assistance in evaluating potential consultants:

1. Competent professionals will ask questions about your situation to see whether they can offer services that will assist you.

The causes and potential remedies for indoor air quality problems vary greatly. A firm needs at least a preliminary understanding of the facts about what is going on in your building to evaluate if it can offer the professional skills necessary to address your concerns and to make effective use of its personnel from the outset.

2. Consultants should be able to describe how they expect to form and test explanations for and solutions to the problem.

Discuss the proposed approach to the building investigation. It may involve moving suspected contaminant sources or manipulating HVAC controls to simulate conditions at the time of complaints or to test possible corrective actions. Poorly designed studies may lead to conclusions that are either "false negative" (i.e., falsely concluding that there is no problem) or "false positive" (i.e., falsely concluding that a specific condition caused the complaint).

Some consultants may produce an inventory of problems in the building without determining which, if any, of those problems caused the original complaint. If investigators discover IAQ problems unrelated to the concern that prompted the evaluation, those problems should be noted and reported. However, it is important that the original complaint is resolved.

3. Decisions to make IAQ measurements should be well-justified.

A decision to obtain IAQ-related measurements should follow logically from other investigative activities. Before starting to take measurements, investigators need a clear understanding of how the results will be used. Without this understanding, it is impossible to plan appropriate sampling locations and times, instrumentation, and analysis procedures. Non-routine measurements [such as relatively expensive sampling for volatile organic compounds (VOCs)] should not be conducted without site-specific justification.

Concentrations low enough to comply with industrial occupational standards could still be harmful to children, or other school occupants. Also, industrial IAQ problems tend to arise from high levels of individual chemical compounds, so standards set limits for individual contaminants or

contaminant classes. Exposure standards of this type are rarely exceeded in schools. Instead, IAQ investigators often find a large number of potential sources contributing low levels of many contaminants to the air.

4. A qualified IAQ investigator should have appropriate experience, demonstrate a broad understanding of indoor air quality problems and the conditions that can lead to them (e.g., the relationship between IAQ and the building structure, mechanical systems, sources, and human activities), and use a phased diagnostic approach.

Have the firm identify the personnel who would be responsible for your case, their specific experience, and related qualifications. Contract only for the services of those individuals, or require approval for substitutions. When hiring an engineer, look for someone with the equipment and expertise to carry out a ventilation system assessment, and with a strong background of field experience. Some engineers rarely get out of the office.

5. In the proposal and the interview, a prospective consultant should present a clear, detailed picture of the proposed services and work products, including the following information:

- the basic goal(s), methodology, and sequence of the investigation, the information to be obtained, and the process of hypothesis development and testing, including criteria for decision-making about further data-gathering.
- any elements of the work that will require a time commitment from school staff, including information to be collected by the school.
- the schedule, cost, and work product(s), such as a written report, specifications, and plans for mitigation work; supervision of mitigation work; and training program for school staff.
- additional tasks (and costs) that may be part of solving the IAQ problem but are outside the scope of the contract. Examples include: medical examination of complainants, laboratory fees, and contractor's fees for mitigation work.
- communication between the IAQ professional and the client: How often will the contractor discuss the progress of the work with the school? Who will be notified of test results and other data? Will communications be in writing, by telephone, or face-to-face? Will the consultant meet with students and/or school staff to collect information? Will the consultant meet with staff, parent organizations, or others to discuss findings, if requested to do so?
- references from clients who have received comparable services.

IAQ-Related Ventilation Modifications

The most important thing for the school's representatives to remember is: Oversee the work and ask questions that will help you assure that the work is properly performed. Specialized measurements of air flows or pre- and post-mitigation contaminant concentrations may be needed to know whether the corrective action is functioning properly.

Performance specifications can be used as part of the contract package to establish critical goals for system design and operation. Performance specifications can be used to force contractors to demonstrate that they have met those goals. At the same time, performance specifications should avoid dictating specific design features such as duct sizes and locations, thus leaving HVAC system designers free to apply their professional expertise. You may be able to adapt appropriate sections of the following sample performance specifications for your school.

Performance Specifications

- *The control system shall be modified and the ventilation system repaired and adjusted as needed to provide outdoor air ventilation during occupied hours. The amount of outdoor air ventilation shall meet ASHRAE Standard 62-1989 minimum recommendations, or shall be the maximum possible with the current air handling equipment, but in no case shall the minimum outdoor air ventilation rate be less than the ventilation guideline in effect at the time the school was constructed.*
- *When designing the ventilation system modifications, it is important to ensure that: 1) increased outdoor air intake rates do not negatively impact occupant comfort, 2) heating coils do not freeze, and 3) the cooling system can handle the increased enthalpy load. A load analysis shall be performed to determine if the existing heating (or cooling) plant has the capacity to meet the loads imposed by the restored or increased ventilation rates. If the existing plant cannot meet this load or, if for some other reason, it is decided not to use the existing heating system to condition outdoor air, then a heating (or cool-*

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ing) plant shall be designed for that purpose. The proposal shall include a life-cycle cost analysis of energy conservation options (e.g., economizer cooling, heat recovery ventilation).

- *All screens in outdoor air intakes shall be inspected for proper mesh size. Screens with mesh size smaller than $^1/_2$ inch are subject to clogging; if present, they shall be removed and replaced with larger-sized mesh (not so large as to allow birds to enter).*

Demonstrating System Performance

- *The proper operation of control sequence and outdoor air damper operation shall be verified by school personnel or the school's agent after ventilation system modifications and repairs have been completed. This shall include, but not be limited to: observation of damper position for differing settings of low limit stats and room stats, measurement of air pressure at room stats and outdoor air damper actuators, direct measurement of air flow through outdoor air intakes, and direct measurement of air flows at exhaust grilles. The contractor shall provide a written report documenting: 1) test procedures used to evaluate ventilation system performance, 2) test locations, 3) HVAC operating conditions during testing, and 4) findings.*

Institutionalizing the Corrective Action

- *After the ventilation system modifications are completed, school facility operators shall be provided with training and two copies of a manual that documents the ventilation system control strategy, operating parameters, and maintenance requirements.*

Codes and Regulations

Pollutant-Related Regulations

The Federal government has a long history of regulating outdoor air quality and the concentrations of airborne contaminants in industrial settings. In an industrial environment, specific chemicals released by industrial processes can be present in high concentrations. It has been possible to study the health effects of industrial exposures and establish regulations to limit those exposures.

Some States have established regulations regarding specific pollutants in schools, such as testing for radon and lead.

Indoor air quality in schools, however, presents a different problem. A large variety of chemicals, used in classrooms, offices, kitchen and cleaning applications, exist at levels that are almost always lower than the concentrations found in industry. The individual and combined effects of these chemicals are very difficult to study, and the people exposed include pregnant women, children, and others who may be more susceptible to health problems than the adult males typically present in regulated industrial settings.

There is still much to learn about the effects of both acute (short-term) and chronic (long-term) exposure to low levels of multiple indoor air contaminants. At this time, there are few Federal regulations for airborne contaminants in non-industrial settings. OSHA (the Occupational Safety and Health Administration) is the Federal agency responsible for workplace safety and health. In the past, OSHA focused primarily on industrial worksites, but most recently has broadened its efforts to address other worksite hazards. In Spring 1994, OSHA introduced a proposed rule regarding IAQ in non-industrial environments. School employees may be able to obtain help (in the form of training and information) from their State OSHA on how to reduce their exposure to potential air contaminants. In States without OSHA organizations, the regional U.S. OSHA contact may be able to provide information or assistance (see *Resources,* **Appendix I**).

Ventilation-Related Regulations

Ventilation is the other major influence on indoor air quality that is subject to regulation. The Federal government does not regulate ventilation in non-industrial settings. However, many State and local governments do regulate ventilation system capacity through their building codes.

Building codes have been developed to promote good construction practices and prevent health and safety hazards. Professional associations such as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and the National Fire Protection Association (NFPA) develop recommendations for appropriate building and equipment design and installation (e.g., ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor

Air Quality). Those recommendations acquire the force of law when adopted by State or local regulatory bodies. There is generally a time lag between the adoption of new standards by consensus organizations such as ASHRAE and the incorporation of those new standards as code requirements. Contact your local code enforcement official, your State's Education Department or a consulting engineer to learn about the code requirements that apply to your school.

In general, building code requirements are only enforceable during construction and renovation. When code requirements change over time (as code organizations adapt to new information and technologies), buildings are usually not required to modify their structure or operation to conform to the new codes. Indeed, many buildings do not operate in conformance with current codes, or with the codes they had to meet at the time of construction. For example, the outdoor air flows that ASHRAE's Standard 62 recommends for classrooms were reduced from 30 cfm/person to 10 cfm/person in the 1930's, and reduced again to 5 cfm/person in 1973 in response to higher heating fuel costs resulting from the oil embargo. Concern over indoor air quality stimulated reconsideration of the standard, so that its most recent version, Standard 62-1989, calls for a minimum of 15 cfm/person in classrooms. However, many schools that reduced outdoor air flow during the "energy crisis" continue to operate at ventilation rates of 5 cfm/person or less. This underventilation is contrary to current engineering recommendations, but, in most jurisdictions, it is not against the law.

Basic Measurement Equipment

To prevent or resolve indoor air quality (IAQ) problems effectively and efficiently, you must be able to make four basic measurements relating to the air within the school. Your school may already own some or all of the equipment necessary to make these measurements. If not, it is important to buy or borrow that equipment to accurately assess the IAQ conditions in your school and ensure that the ventilation equipment is working properly (which can save the school money in heating and cooling bills), as well as improve IAQ.

There are four measurements that are important to the activities in this guide:

- Temperature
- Relative humidity
- Air movement
- Airflow volume

In addition, a CO_2 monitor is useful for indicating when outdoor air ventilation may be inadequate (see the *Ventilation Checklist*).

School management may be nervous about spending money on measurement equipment. This Guide does not recommend sampling for pollutants, which is difficult to interpret and can require costly measurement equipment and significant training and experience. The activities described in this guidance are likely to prevent or uncover problems more effectively than pollutant sampling. The four measurements just listed do not require expensive equipment or special training and are straightforward to interpret. The equipment to measure these four factors is readily available (see the sources table).

If your school's budget does not allow for purchase of some or all of the equipment, try a cooperative approach:

- Combine resources with other schools in the district or neighboring schools
- Contact school organizations and local government to inquire about cooperative purchasing options
- Borrow equipment from another school, district, or a State or local government

Do not let lack of some equipment prevent you from conducting the majority of activities. Conduct all recommended activities possible with the equipment you have available. If you cannot secure resources for obtaining the recommended equipment, prioritize your equipment purchases as follows:

1. Temperature, relative humidity, and chemical smoke device for indicating air movement

2. Airflow volume measuring devices

3. CO_2 monitor

Sources of Measurement Equipment

The following list of equipment sources is provided for general information only. EPA does not endorse, recommend, or certify this equipment or its sources, and other sources of this equipment may be available. The price in parentheses indicate suggested list price(s) for the model(s) carried by the source.

Typical Equipment and Uses	Sources
Temperature and Relative Humidity Thermal comfort measurements can be made with a simple thermometer and sling psychrometer or with electronic sensors, such as a thermohygrometer.	Check with a local supplier of heating and ventilating equipment. Prices vary widely according to type.
Air Movement Chemical smoke (titanium tetrachloride) is available with various dispensing mechanisms, including smoke bottles, guns, pencils, or tubes. The dispensers allow smoke to be released in controlled quantities and directed at specific locations. Smoke generator sticks and guns ($40-$90)	**E. Vernon Hill, Inc.** 940 Adam St., Ste G Benicia, CA 94510 (707) 747-5577 (707) 747-1534 (fax) **Mine Safety Appliances** P.O. Box 426 Pittsburgh, PA 15230 (800) 672-222 (412) 967-3000 (412) 967-3552 (fax) **National Draeger** 101 Technology Drive Pittsburgh, PA 15275 (800) 922-5518 (412) 787-8383 (412) 787-2207 (fax)
Quantity of Air Several devices are used to measure quantity of air flowing in a duct or at a vent. Pitot tubes and anemometers measure air velocity in an airstream and can be used in ductwork. Flow hoods can be used for direct measurement of airflow at grilles, diffusers, and exhaust outlets (they are easier to use and more reliable than other methods of measuring airflow at these locations). They are not designed for use in ductwork. Check with manufacturers for models that meet your needs.	**Airflow Technical Products, Inc.** P.O. Box 8552 Landing, NJ 07850-0552 (800) 247-8887 (201) 691-4825 (201) 691-4703 (fax) **Alnor Instrument Co.** 7555 N. Linder Ave. Skokie, IL 60077 (800) 427-7429 (708) 677-3500 (708) 677-3539 (fax) **Dwyer Instruments, Inc.** P.O. Box 373 Michigan City, IN 46360 (219) 879-8000 (219) 879-9057 (fax) **Shortridge Instruments, Inc.** 7855 E. Redfield Rd. Scottsdale, AZ 85260 (602) 991-6744 (602) 443-1267 (fax)
Carbon Dioxide Carbon dioxide (CO_2) is best measured using a direct reading meter, especially one with a logging device. Detector tubes for measuring CO_2 can be difficult to read accurately. CO_2 is used as a rough indicator of effectiveness of ventilation (CO_2 levels above 1000 parts per million indicate inadequate ventilation with outdoor air). CO_2 can also be used to obtain an estimate of outdoor air quantity.	**CEA Instruments, Inc.** ($600-$3000) 16 Chestnut St. Emerson, NJ 07630 (201) 967-5660 (201) 967-8450 (fax) **California Analytical, Fuji** ($3000) 1238 West Grove Avenue Orange, CA 92665-4134 (800) 959-0949 (714) 974-5560 (714) 921-2531 (fax) **The Dickson Company** ($899-$925) 930 S. Westwood Ave. Addison, IL 60101 (800) 323-2448 (708) 543-3747 (708) 543-0498 (fax) **Gastech, Inc.** ($2800) P.O. Box 390726 Mountain View, CA 94039 (510) 745-8700 (510) 794-6201 (fax) **Horiba Instruments** ($2500) 17671 Armstrong Ave. Irvine, CA 92714 (800) 446-7422 (714) 250-4811 (214) 250-0924 (fax) **Metrosonics Inc.** ($3750-7300) P.O. Box 23075 Rochester, NY 14692 (716) 334-7300 (716) 334-2635 (fax) **Solomat Neotronics** ($500-5000) 2144 Hilton Drive, SW Gainesville, GA 30501 (800) 535-0606 (404) 535-0600 (404) 532-9282 (fax) **Telaire Systems, Inc.** ($475-1400) 6489 Calle Real Goleta, CA 93117 (800) 472-6075 (805) 964-1699 (805)964-2129 (fax) **TSI Incorporated** ($2900) P.O. Box 64394 St. Paul, MN 55126 (612) 490-2888 (612) 490-2874 (fax)

Developing Indoor Air Policies

If there have been problems with staff understanding verbal communication regarding specific activities that affect indoor air quality (IAQ), or if staff follow-through is a problem, a written IAQ policy statement regarding specific IAQ issues may help prevent future problems.

An IAQ policy statement demonstrates a strong commitment by the school administration to address the health and comfort of staff and students, as well as the environmental quality in the school. In addition, an IAQ policy sets an overall direction for efforts to prevent and correct IAQ problems. General issues which may require policies include, but are not limited to: painting; smoking; renovations and repairs; pest management; ventilation system operation; school supply and purchasing; and disinfectants.

This appendix presents general considerations related to developing an IAQ policy. In addition, it presents three sample IAQ policies targeted to specific indoor pollutant sources. The first sample is a policy on integrated pest management (IPM) developed by EPA. The second sample is a memo on painting, and includes an information letter to parents. The final sample is a nonsmoking policy, including a sample letter to staff. The nonsmoking policy was developed based on a review of model policies from the American Cancer Society, the American Lung Association, and sample policies from various companies and organizations. The samples presented are only intended as guides, and may be modified in any way to meet the site-specific needs and intent of individual schools.

General Considerations

An IAQ policy could include the following components:

- a statement indicating that the school administration is concerned about IAQ and the health, safety, and comfort of staff and students
- a statement indicating that the school administration is committed to preventing and correcting IAQ problems
- authorization of an IAQ Coordinator for each school or district and delegation of authorities to the IAQ Coordinator
- guidance on appropriate steps for maintaining good IAQ (see specific activities in the various IAQ Checklists for ideas)
- guidance on appropriate actions for correcting IAQ problems
- reporting requirements

Developing an IAQ policy should be an open process. A health and safety committee is a good forum for developing consensus recommendations. In the absence of an existing committee, consider establishing an ad hoc committee including administrators, teachers, support personnel, school health officers, maintenance personnel, physicians and community leaders. Interested parents may also wish to serve on this committee.

Sample School Pest Management Policy Statement

When it is determined that a pesticide must be used in order to meet important management goals, the least hazardous material adequate to control the pest will be chosen and label directions shall be followed. The application of pesticides is subject to the Federal Insecticide, Fungicide, and Rodenticide Act (7 United States Code 136 et seq.), school district policies and procedures, Environmental Protection Agency regulations in 40 Code of Federal Regulations, Occupational Safety and Health Administration regulations, and state and local regulations.

Education

Staff, students, pest managers, and the public will be educated about potential school pest problems and the IPM policies and procedures to be used to achieve the desired pest management objectives.

Record Keeping

Records of pesticide use shall be maintained on site to meet the requirements of the state regulatory agency and School Board. Records must be current and accurate if IPM is to work. In addition, pest surveillance data sheets that record the number of pests or other indicators of pest populations are to be maintained to verify the need for treatments.

Notification

This School District takes the responsibility to notify the school staff and parents in advance of pesticide applications.

Pesticide Storage and Purchase

Pesticide purchases will be limited to the amount authorized for use during the year. Pesticides will be stored and disposed of in accordance with the EPA-registered label directions and state regulations. Pesticides must not be accessible to students or unauthorized personnel.

Pesticide Applicators

Pesticide applicators must have a working knowledge of the principles and practices of IPM, and use only pesticides approved by this School District. They must follow regulations and label precautions. Applicators must comply with this School District IPM policy and Pest Management Plan.

Pests and pesticides can pose significant problems and risks to people, property, and the environment. It is therefore the policy of [school name] to incorporate Integrated

continued...

Pest Management (IPM) procedures for control of structural and landscape pests. This policy will minimize the amount and toxicity of pesticides used in the school.

Pests

Pests are populations of living organisms (animals, plants, or microorganisms) that interfere with use of the school site for human purposes. Strategies for managing pest populations will be influenced by the pest species and whether that species poses a threat to people, property, or the environment.

Pest Management

Approved pest management plans should be developed for the site and should include any proposed pest management measures.

Pests will be managed to:

- Reduce any potential human health hazard or to protect against a significant threat to public safety.
- Prevent loss of or damage to school structures or property.
- Prevent pests from spreading into the community, or to plant and animal populations beyond the site.
- Enhance the quality of life to students, staff, and others.

Integrated Pest Management Procedures

IPM procedures will be used to determine when to control pests and whether to use mechanical, physical, chemical, or biological means. IPM practitioners depend on current, comprehensive information on the pest and its environment and the best available pest control methods. Applying IPM principles prevents unacceptable levels of pest activity and damage by the most economical means and with the least possible hazard to people, property, and the environment.

The decision to use a pesticide will be based on a review of all other available options and a determination that these options are not acceptable or are not feasible. Cost or staffing considerations alone will not be adequate justification for use of chemical control agents, and selected non-chemical pest management methods will be implemented whenever possible to provide the desired control. It is the policy of this School District to utilize IPM principles to manage pest populations adequately. The full range of alternatives, including no action, will be considered.

Excerpts from a Painting Memo

TO: School Principal

FROM: District Facilities Manager

This memo, with attachments, is provided for your use in preparation for the interior painting of your school. Based on past experience, certain steps must be taken by the school prior to the beginning of work to ensure that minimum disruption occurs to the teaching process and maximum information is communicated to the parents.

The Paint Foreman or his designated representative will meet with you no later than one month prior to the start of work to coordinate the effort and discuss any items which may be of interest to you. At a minimum, he will need your room by room painting priority to schedule his work force in your school. Clearly, classrooms or other confined spaces must be vacated throughout the painting process. The attached Material Safety Data Sheets will provide information on drying time and other precautions which must be taken. The principal reserves the right not to occupy a classroom until he/she is satisfied occupancy will not pose a hazard to the students. The paint crew generally can complete an average classroom in one day.

As it pertains to cafeterias, painting will not start until after lunch is completed. This means painting will occur only two to three hours in the afternoon each working day. Clearly the painting of this facility will take longer than in any other part of the school.

The attached notices to parents are provided for school consideration. All parents must be notified by some means. Two choices are offered, one in the form of an official memorandum; the other, less formal, was designed to be a "flyer."

You may have one or more parents express concern over their child's presence in school during the painting. Since the length of time required to paint the interior of your school will be a minimum of three months, you and the parent(s) will have to mutually resolve this issue on a case by case basis. The Office of Health Issues, ###-####, should be contacted for assistance if such concerns do arise.

If you have any questions concerning this memo or the painting process, please contact the Paint Department at ###-####, or discuss your questions or concerns at the scheduled pre-painting meeting.

Source: "Indoor Air Quality Management Program," Anne Arundel County Public Schools, Maryland

Sample Parental Notification Letter for School Painting

Name

Address

City, State, Zip Code

Dear Parents:

The Maintenance Division plans to start painting in our school on or about [day and date].

The school plant is an important factor in the functioning of the total educational program. Proper maintenance of school buildings is necessary to provide a healthy and pleasant atmosphere. The majority of paint being used in [name] Public Schools is latex water-based. Some heavy traffic areas and trim will require the use of oil-based paint. Paints containing lead or mercury are never used in school painting.

Instructional areas will be empty during painting and drying times, and children will not be in the cafeteria while it is being painted.

We anticipate that paint crews will be in the school for a period of [# of days], beginning on [day and date].

The health and safety of all students is a primary consideration as the painting crews undertake this maintenance and beautification project. If you have any questions or concerns about the scheduled painting, please feel free to contact me at [phone #].

With the cooperation of parents, students, and staff, this painting project will result in a bright, new look for our school. I hope you will stop by when the project is completed to see the results for yourself!

Sincerely,

Principal

Source: "Indoor Air Quality Management Program," Anne Arundel County Public Schools, Maryland

Nonsmoking Policies

This section includes a sample announcement policy and sample nonsmoking memo. The announcement letter should address the six main issues covered by the school's nonsmoking policy:

- Explicitly state where smoking is prohibited and permitted (if permitted at all).
- Define individuals who are covered by the policy.
- Clarify exactly what constitutes smoking.
- Outline the stages and dates of policy implementation.
- State the enforcement procedures taken when the policy is violated.
- Identify the appropriate contact for questions and concerns.

The sample policy is intended to provide a framework for developing a nonsmoking policy and highlights issues of particular importance for both large and small schools. The level of detail and specificity of any policy will depend on the type of school, the actions to be taken, and the level of guidance required to effectively communicate the policy to all affected individuals. A simple, clear-cut policy, for example, will require few specifics and will be easily enforced as well.

The nonsmoking policy should be placed in the personnel manual, employee handbook, school by-laws, or another location that will facilitate the distribution of this information to all affected individuals. There are five main issues that should be addressed by the policy:

- Why the school is pursuing such a policy.
- What is considered smoking.
- Where and/or when smoking is and is not permitted.
- The procedures for voicing concerns and resolving conflicts.
- The enforcement procedures supporting the implementation of the policy.

The policy may also include information on smoking cessation or other staff education programs being offered or covered by the school.

Following is a sample nonsmoking policy that eliminates smoking indoors. If separately ventilated designated smoking rooms are being provided, this policy can be easily revised by omitting the step about eliminating smoking within the school building. Add more specifics regarding the exact locations where smoking is prohibited and permitted, as well as additional enforcement procedures for potential and repeated infractions.

For additional information on environmental tobacco smoke, see **Appendix F.**

Sample Nonsmoking Policy

[Forest Lake School] is committed to providing a healthy and productive environment for all persons using our school. In light of the significant risk posed by second-hand tobacco smoke and involuntary smoking to human health as well as to sensitive equipment, [Forest Lake] has decided to implement a [nonsmoking policy or smoke control policy]. This policy is intended to improve the health and safety of all individuals using the school. The following steps indicate the exact timing of specific changes to current operations and outline the procedures for conflict resolution and enforcement.

I. Implementation of Policy to [Eliminate or Reduce] Exposure to ETS

A. Beginning in [August], [Forest Lake] will offer smoking cessation programs to all school staff.

B. Effective [October 1], smoking will be prohibited in all [Forest Lake] school buildings and facilities. Additional "No Smoking" signs will be posted as necessary to remind personnel and visitors of this policy. [NOTE: This bullet may be eliminated if implementing a less stringent policy.]

[Alternative Text for Separately Ventilated Smoking Room Policy:

Effective [October 1], smoking will be prohibited in meetings, and all enclosed areas including conference rooms, offices, and rest rooms. Smoking will also be prohibited in all common areas, including the cafeteria, break rooms, hallways, reception areas, and outside building entrances. "No Smoking" signs will be posted in the restricted areas. Smoking will only be permitted in designated rooms which have been equipped with separate exhaust fans that isolate environmental tobacco smoke (ETS) from nonsmoking areas. [NOTE: See **Appendix F** if school is receiving federal funding.]

II. Conflict Resolution

Employees and visitors are expected to honor the smoking restrictions at all school buildings and facilities. Individual complaints or concerns regarding the implementation and/or enforcement of this policy should be discussed with your supervisor [or other designated person]. If the supervisor is unable to resolve the individual complaint or concern, the employee may request that their concern be directed to the Nonsmoking Policy Committee [or other designated person or committee].

III. Enforcement of Policy

All persons share in the responsibility of adhering to and enforcing this policy. Any person violating this policy will be subject to the same disciplinary actions that accompany any infraction of our policies including:

- Employee counseling
- Oral reminder
- Written reprimand
- Probation
- Termination

Sample Nonsmoking Announcement Memo

To: All [Forest Lake] School Staff

From: [Name], Principal

Re: [Forest Lake's] Nonsmoking Policy

In response to EPAs recent findings that secondhand smoke is responsible for approximately 3,000 lung cancer deaths each year and increasing staff concern, [Forest Lake] is instituting a smoke-free workplace policy, effective [date]. This policy applies to all property owned or leased by [Forest Lake] and includes all offices, hallways, waiting rooms, rest rooms, lunch rooms, elevators, meeting rooms, and community areas. This policy applies to all staff and visitors. Smoking will be allowed outside of buildings, such as in the parking lot. Smoking will not be allowed adjacent to the building entrances.

[Forest Lake] considers any use of tobacco products which produce smoke as smoking. This definition includes, but is not limited to, cigars, cigarettes, and pipes.

[Forest Lake] has taken several steps to facilitate a smooth transition to a smoke-free workplace:

- The policy will be phased in over a period of three months, beginning in [month].
- Beginning in [month], a smoking cessation class will be offered for individuals who would like to take this opportunity to quit smoking. Smoking cessation classes will continue to be offered through [month & year].
- Effective [date] smoking will be prohibited in all common areas. Smoking will be permitted in private offices only.
- Effective [date], smoking will be prohibited throughout all buildings.

The success of this policy will depend upon the thoughtfulness, consideration, and cooperation of smokers and nonsmokers. Everyone shares in the responsibility for adhering to and enforcing the policy. Any problems should be brought to the attention of the appropriate supervisor and handled through the normal chain of command. Individuals who violate this policy will be subject to the same disciplinary actions that accompany infraction of other school rules. Refer to your employee handbook for disciplinary policies.

The [Forest Lake] school administration welcomes questions and comments regarding the new nonsmoking policy. Please feel free to contact our Indoor Air Quality Coordinator, [name], at extension [####]; [he /she] will be happy to respond to your questions and concerns and can provide information on the health effects of secondhand tobacco smoke.

Typical Indoor Air Pollutants

The following four pages present information about several indoor air pollutants common to schools, in a format that allows for easy comparison. The pollutants presented include:

- Tobacco smoke
- Formaldehyde
- Other volatile organic compounds
- Nitrogen oxides
- Carbon monoxide
- Carbon dioxide
- Allergens and pathogens
- Radon
- Pesticides
- Lead
- Dust

Each pollutant is described or analyzed across six categories:

- Description
- Sources
- Standards and guidelines
- Comfort and health effects
- Measurement methods
- Control measures

Indoor Air Pollutants	Description	Sources	Standards & Guidelines
Tobacco Smoke	Tobacco smoke consists of solid particles, liquid droplets, vapors, and gases resulting from tobacco combustion. Particles of condensed combustion products are almost in the respirable range and over 4,000 specific materials have been identified in the particulates and associated gases.	Tobacco combustion.	No general levels have been agreed upon. ASHRAE Standard 62-1989 specified dilution with smoke-free air at 60 cubic feet per minute per person in smoking rooms.
Formaldehyde	Formaldehyde is a colorless water-soluble gas. Due to its wide use, it is frequently considered separately from other volatile organic compounds (VOCs).	Materials containing formaldehyde are used widely in buildings, furnishings, and some consumer products. Formaldehyde-based resins are used in the manufacture of plywoods, particleboard, textiles, and adhesives. Urea-formaldehyde (UF) resins are commonly used in interior-grade plywood and pressed wood furniture, cabinets, and shelving. The walls of some buildings have been insulated with urea-formaldehyde foam insulation (UFFI). Phenol-formaldehyde (PF) resins are normally used in exterior grade products. Formaldehyde outgasses from the above mentioned products. UF-based products typically emit higher levels of formaldehyde than the PF-based materials. Tobacco smoke and other combustion products are secondary formaldehyde sources. Indications are that outgassing from materials diminishes over time.	No Federal standard has been set for formaldehyde, however, OSHA now regulates formaldehyde as a carcinogen. OSHA has adopted a Permissible Exposure Level (PEL) of 0.75 ppm, and an action level of 0.5 ppm. OSHA also requires labeling informing exposed workers about the presence of formaldehyde in products entering workplaces that can cause levels to exceed 0.1 ppm. Some States have established a standard of 0.4 ppm in their codes for residences; others have established much lower recommendations (e.g., the CA guideline is 0.05 ppm). Based upon current information, it is advisable to mitigate formaldehyde that is present at levels higher than 0.1 ppm.
Other Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs)	There are hundreds of other VOCs found in indoor air, sometimes in concentrations that are suspected of being harmful.	Acetone (cleaners, personal care products, tobacco smoke), acrolein (tobacco smoke), alcohols (cleaners, personal care products, tobacco smoke), aromatic hydrocarbons (adhesives, combustion processes, gasoline, paints, pesticides, solvents, tobacco smoke), benzene (combustion processes, gasoline, solvents, tobacco smoke), chlorinated hydrocarbons (PCBs, wood preservatives, solvents), phenols (equipment, furnishings, tobacco smoke), and methanol (duplicating machines).	No standards have been set for VOCs in nonindustrial settings. NIOSH has recommended occupational standards for many compounds.
Nitrogen Oxides	The two most prevalent oxides of nitrogen are nitrogen dioxide (NO_2) and nitric oxide (NO). Both are toxic gases with NO_2 being a highly reactive oxidant, and corrosive. NO gradually reacts with the oxygen in the air to form NO_2.	The primary sources indoors are combustion processes, such as unvented combustion appliances, vented appliances with defective installations, welding, and tobacco smoke.	No standards have been agreed upon for nitrogen oxides in indoor air. ASHRAE and the U.S. National Ambient Air Quality Standards lists 100 µg/m3 (.053 ppm) as the average long-term (1-year) limit for NO_2 in outdoor air.
Carbon Monoxide	Carbon monoxide (CO) is a colorless, odorless, and tasteless gas. It results from incomplete oxidation of carbon in combustion.	Incomplete oxidation during combustion in gas ranges and unvented gas or kerosene heaters may cause high concentrations of CO in indoor air. Worn or poorly adjusted and maintained combustion devices (e.g. boilers, furnaces) can be significant sources, or if the flue is improperly sized, blocked, disconnected, or is leaking. Auto, truck, or bus exhaust from attached garages, nearby roads, or parking areas can also be a source.	No standards for CO have been agreed upon for indoor air. The U.S. National Ambient Air Quality Standards for outdoor air are 9 ppm (40,000 $\mu g/m^3$) for 8 hours, and 35 ppm for 1 hour.

Comfort & Health Effects	Measurement Methods	Control Measures
The effects of tobacco smoke on smokers are well known. Environmental tobacco smoke (secondhand smoke) has multiple health effects on children. Secondhand smoke has been classified as a "Group A" carcinogen by EPA. Tobacco smoke remains in the air for hours and attracts radon decay products, which are also hazardous.	Particulate concentration is measured by optical scattering or gravimetrically by particles collected on filters. Gas chromatographs are used to study gaseous components. Enough work has been done so that reasonable estimates of the source strength can be made by simply counting smokers and estimating that about 25 percent of adults smoke and consume about two cigarettes per hour.	Prohibition of smoking in public spaces is common. Isolation of smokers is potentially effective, but requires careful management of ventilation. Dilution is often not effective; very large ventilation rates are necessary to dilute smoke levels enough to be unobjectionable to most nonsmokers.
Formaldehyde has a pungent odor and is detected by many people at levels of about 0.1 ppm. Besides the annoyance, it also causes acute eye burning and irritates mucous membranes and the respiratory tract. EPA has determined formaldehyde to be a probable human carcinogen, but the Agency believes that the risk of cancer is minimal at exposure levels typically encountered in indoor residential settings.	Inexpensive passive samplers and detector tubes have been developed. The more accurate method of collecting formaldehyde is by impingers. Concentrations are then determined by colorimetric methods.	Increased temperature and humidity will accelerate outgassing. Therefore ventilation may not be an effective means for mitigation. Some manufacturers are producing products with lower outgassing rates. Some surface treatments are being used to seal against outgassing, but long-term effectiveness is still being studied.
Several of these compounds have been identified individually as causing acute and chronic effects at high concentrations. A few have been directly linked to cancer in humans and others are suspected of causing cancer.	Gas chromatographs and portable photoionization meters are used for laboratory and field studies to measure VOC concentrations. No inexpensive monitors suitable for extensive field use currently exist.	Where practical, uses of these sources should be restricted, and these materials should be stored in properly sealed containers, and in well ventilated areas apart from occupied zones.
Oxides of nitrogen have no sensory effect at low concentrations, but produce short-term effects on airway activity. High concentrations can lead to acute lung dysfunction. Special risks exist for chronic bronchitis, emphysema, asthma, and children under two years old. Chronic effects are not well established.	Small, inexpensive, passive NO_2 monitors suitable for field use are available. Nondispersive infrared techniques are used to measure nitrogen oxides in laboratory settings or for continuous monitoring.	Venting the NO_2 source to the outdoors is the most practical measure for existing conditions. Manufacturers are developing devices which generate lower NO_2 emissions.
Acute effects are due to the formation of carboxyhemoglobin in the blood, which inhibits oxygen intake. At moderate concentrations, angina, impaired vision, and reduced brain function may result. At higher concentrations, CO exposure can be fatal.	Some relatively high-cost infrared radiation absorption and electrochemical instruments do exist. Moderately priced real-time measuring devices are also available. A passive monitor is currently under development.	It is most important to be sure combustion equipment is maintained and properly adjusted. Vehicular use should be carefully managed adjacent to buildings and in vocational programs. Additional ventilation can be used as a temporary measure when high levels of CO are expected for short periods of time.

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Indoor Air Pollutants	Description	Sources	Standards & Guidelines
Carbon Dioxide	Carbon dioxide (CO_2) is a colorless, odorless, and tasteless product of completed carbon combustion.	All combustion processes and human metabolic processes are sources of CO_2. Concentrations of CO_2 from people are always present in all occupied buildings.	ASHRAE Standard 62-1989 recommends 1,000 ppm as the upper limit for comfort (odor) reasons.
Allergens and Pathogens	Biological material, including bacteria, viruses, fungi, mold spores, pollens, skin flakes and insect parts are ubiquitous in indoor environments. These particulates range from less than one to several microns in size. When airborne, they are usually attached to dust particulates of various sizes so that all sizes of airborne particulates may include them.	People, animals, and the environment produce biological materials. Drapery, bedding, carpet, and other places where dust collects can harbor them. Cooling towers can be incubators of *Legionella* bacteria. Dirty cooling coils, humidifiers, condensate drains, and ductwork can incubate bacteria and molds. High humid-ity areas exacerbate their growth.	No standards exist for general indoor air applications except that ASHRAE recommends a relative humidity between 30 and 60 percent.
Radon	Radon is a colorless, odorless, and tasteless radioactive gas, the first decay product of radium-226. It decays into solid alpha emitters which can be both inhaled directly or attached to dust particles that are inhaled. The unit of measure for radon is picocuries per liter (pCi/L).	Radium is ubiquitous in the earth's crust in widely varying concentrations. Well water can have high concentrations of radon. Masonry building blocks can have radium concentrations. The earth around buildings, however, is the principal source of indoor radon. Radon penetrates cracks and drain openings in foundations, into basements and crawl spaces. Water containing radon will outgas into spaces when drawn for use indoors. Some building materials will outgas radon, some of which may enter buildings.	EPA recommends taking action to mitigate radon if levels exceed 4 pCi/l. ASHRAE Standard 62-1989 recommends levels not to exceed 2 pCi/L.
Pesticides	Pesticides are chemicals that are used to kill or control pests which include bacteria, fungi, weeds, and other organisms, in addition to insects and rodents. Most pesticides are inherently toxic. Most contain volatile organic compounds.	Pesticides are widely used to reduce pests associated with indoor plants, pets, wood, and woolen products. Pesticides may be applied indoors or be tracked in from the outdoors.	No air concentration standards for pesticides have been set, however, EPA recommends Integrated Pest Management, which minimizes the use of chemical pesticides. Pesticide products should be used according to application and ventilation instructions provided by the manufacturer.
Lead	Lead is a highly toxic metal.	Exposure to lead can come from drinking water, food, contaminated soil and dust, and air. Lead-based paint is a common source of lead dust.	The Consumer Product Safety Commission (CPSC) has banned lead in paint. All other standards are for outdoor air or industrial workplaces. EPA is developing standards for abating lead-based paint.
Dust	Dust is comprised of particles in the air that settle on surfaces. Large particles settle quickly and can be trapped by the body's defense mechanisms. Small particles are more likely to be airborne and are capable of passing through the body's defenses and entering the lungs.	Dust can be generated from multiple sources, including soil, fleecy surfaces, pollen, lead-based paint, or from burning wood, oil, or coal.	The EPA Ambient Air Quality standard standard for particles less than 10 microns in diameter is 50 $\mu g/m^3$ for an annual average, and 150 $\mu g/m^3$ for a 24-hour average.

Comfort & Health Effects	Measurement Methods	Control Measures
Carbon dioxide is a simple asphyxiant. At concentrations above 1.5% (15,000 ppm) some loss of mental acuity has been noted.	Instruments exist that are reliable and inexpensive for most commercial applications.	Ventilation with outdoor air is used to control CO_2.
Tuberculosis, measles, staphylococcus infections, and influenza are known to be transmitted by air as is Legionnaires disease. Pollens and molds can cause allergic reactions for a significant portion of the population.	Air samples must be collected on appropriate microbial media and incubated for visual examinations of viable growths. Microscopic examinations of collected dust can be used to identify molds and pollen. No inexpensive field monitors exist that are suitable for large-scale use. Active sampling should be the method of choice (e.g., Anderson two-stage, impactor or impinger). Gravity sampling may give misleading results, and does not provide volumetric data.	General good housekeeping, and maintenance of heating and air conditioning equipment, are very important. Adequate ventilation and good air distribution also helps. Higher efficiency air filters remove viable particles. Employ integrated pest management and disinfectants according to school policy to control insect and animal allergens. Cooling tower treatment procedures exist to reduce levels of *Legionella* and other organisms. Maintaining indoor relative humidity below 60% can be helpful.
Radon is a known human lung carcinogen. This is currently the only known effect based on extensive studies of underground miners (no sensory perception or acute health effects). Radon gas decays into radioactive particles that are retained in the lung and further breakdown releases small bursts of energy. There is evidence of a synergistic effect between cigarette smoking and radon; that is, the risks from exposure to both may exceed the risk from either acting alone. The EPA's estimate of 7000 to 30,000 annual lung cancer deaths in the US due to radon exposure is an estimate for the general population which includes smokers and nonsmokers.	Inexpensive charcoal canisters (less than $15) are available to screen radon concentrations over a four to seven day period. Relatively inexpensive alpha track detectors (less than $50) are available for survey use which integrate radon concentration over a one month to one year period. Air sampling instruments for real time measurements are more expensive. No inexpensive method exists to measure radon decay products concentrations.	Active Soil Depressurization (ASD) and building ventilation are the two most commonly used strategies for controlling radon in schools. Sealing foundations to prevent radon entry as a stand alone strategy is rarely successful. However, sealing major entry points can improve the effectiveness of other strategies. Increased outdoor air ventilation can reduce radon levels by dilution or pressurization of the building. A ventilation based strategy may not be the most effective strategy if the initial radon levels are greater than 10 pCi/L.
The specific symptoms that will result from a given pesticide exposure situation depend on the pesticide and its site of action, the dose received, and the sensitivity of the exposed individual(s). Chronic exposure to some pesticides can result in damage to the liver, kidneys, and nervous system.	EPA evaluates the toxicity of pesticide products, and based on its findings, assigns the following labels to the products: **Danger** (highly poisonous), **Warning** (moderately poisonous), or **Caution** (least hazardous).	Use only the recommended amounts of a pesticide; mix or dilute pesticides outdoors or in a well ventilated area; and dispose of unwanted pesticides safely to minimize exposure.
Lead is capable of causing serious damage to the brain, kidneys, nervous system, and red blood cells. Children are particularly vulnerable, because lead is more easily absorbed into growing bodies, and the tissues of small children are sensitive to its effects. Lead exposure in children can result in delays in physical development, lower IQ levels, shortened attention spans, and increased behavioral problems.	Exposure to lead is estimated by measuring levels in the blood. Neurological testing can also be performed.	Preventative measures to reduce lead exposure include the following: cleaning play areas; mopping floors and wiping window ledges and other areas with damp cloths frequently; keeping children away from areas where paint is chipped or peeling; preventing children from chewing on window sills and other painted areas; and ensuring that hands are washed before mealtimes.
Some dust particles may contain lead, pesticide residues, or other toxic material. Others may be fibrous and be an irritant or carcinogenic (e.g., asbestos).	Particle concentration is measured by optical scattering or gravimetrically by particles collected on filters.	Keep dust to a minimum with good housekeeping. Consider damp dusting and high efficiency vacuum cleaners. Upgrade filters in ventilation systems to medium efficiency when possible and change frequently. To help control dust mites and biological dust, keep RH below 50%. Exhaust combustion appliances to the outside and clean and maintain flues and chimneys.

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Environmental Tobacco Smoke

Environmental tobacco smoke (ETS), also called secondhand smoke, is a mixture of the smoke given off by the burning end of a cigarette, pipe, or cigar, and the smoke exhaled from the lungs of smokers. This mixture contains more than 4,000 substances, more than 40 of which are known to cause cancer in humans or animals and many of which are strong irritants. Exposure to ETS is called involuntary smoking, or passive smoking.

EPA has classified ETS as a known cause of cancer in humans (Group A carcinogen). Passive smoking is estimated to cause 3,000 lung cancer deaths in nonsmokers each year. ETS also causes irritation of the eyes, nose, throat, and lungs. ETS-induced irritation of the lungs leads to excess phlegm, coughing, chest discomfort, and reduced lung function. ETS may also affect the cardiovascular system, and some studies have linked exposure to ETS with the onset of chest pain.

ETS Effects on Children

ETS is a serious health risk to children. Children whose parents smoke are among the most seriously affected by exposure to ETS, being at increased risk of lower respiratory tract infections such as pneumonia and bronchitis. EPA estimates that passive smoking is responsible for between 150,000 and 300,000 lower respiratory tract infections annually, resulting in between 7,500 and 15,000 hospitalizations per year.

Children exposed to ETS are also more likely to have reduced lung function and symptoms of respiratory irritation like cough, excess phlegm, and wheeze. Passive smoking can lead to a buildup of fluid in the middle ear, the most common cause of hospitalization of children for an operation. Asthmatic children are especially at risk.

EPA estimates that exposure to ETS increases the number of episodes and severity of symptoms in hundreds of thousands of asthmatic children. EPA estimates that between 200,000 and 1,000,000 asthmatic children have their condition made worse by exposure to ETS. Passive smoking is also a risk factor for the development of asthma in thousands of children each year.

Recommendations

EPA recommends that every organization dealing with children have a smoking policy that effectively protects children from exposure to ETS. Parent-Teacher Associations, school board members, and school administrators should work together to make children's school environment smoke free.

Key features of smoking education programs include multiple sessions over many grades, social and physiological consequences of tobacco use, information about social influences (peers, parents, and media), and training in refusal skills. School based non-smoking policies are important because the school environment should be free from ETS for health reasons and because teachers and staff are role models for children.

Legislation

The "Pro-Children Act of 1994" prohibits smoking in Head Start facilities, and in kindergarten, elementary, and secondary schools that receive federal funding from the Department of Education, the Department of Agriculture, and the Department of Health and Human Services (except funding from Medicare or Medicaid). The Act was signed into law as part of the "Goals 2000: Educate America Act."

What follows are excerpts from the Act, which took effect December 26, 1994.

Pro-Children Act of 1994

Following are excerpts from Public Law 103-227, March 31, 1994.

SECTION 1042. DEFINITIONS.

(1) CHILDREN. The term "children" means individuals who have not attained the age of 18.

(2) CHILDREN'S SERVICES. The term "children's services" means the provision on a routine or regular basis of health, day care, education, or library services —

(A) that are funded, after the date of the enactment of this Act, directly by the Federal Government or through State or local governments, by Federal grant, loan, loan guarantee, or contract programs —

(i) administered by either the Secretary of Health and Human Services or the Secretary of Education (other than services provided and funded solely under titles XVIII and XIX of the Social Security Act); or

(ii) administered by the Secretary of Agriculture in case of a clinic; or

(B) that are provided in indoor facilities that are constructed, operated, or maintained with such Federal funds, as determined by the appropriate Secretary in any enforcement action under this title, except that nothing in clause (ii) of subparagraph (A) is intended to include facilities (other than clinics) where coupons are redeemed under the Child Nutrition Act of 1966.

(3) PERSON. The term "person" means any State or local subdivision thereof, agency of such State or subdivision, corporation, or partnership that owns or operates or otherwise controls and provides children's services or any individual who owns or operates or otherwise controls and provides such services.

SEC. 1043. NONSMOKING POLICY FOR CHILDREN'S SERVICES.

(a) PROHIBITION. After the date of the enactment of this Act, no person shall permit smoking within any indoor facility owned or leased or contracted for and utilized by such person for provision of routine or regular kindergarten, elementary, or secondary education or library services to children.

(b) ADDITIONAL PROHIBITION. After the date of the enactment of this Act, no person shall permit smoking within any indoor facility (or portion thereof) owned or leased or contracted for and utilized by such person of regular or routine health care or day care or early childhood development (Head Start) services to children or for the use of the employees of such person who provides such services.

(c) FEDERAL AGENCIES.

(1) KINDERGARTEN, ELEMENTARY, OR SECONDARY EDUCATION OR LIBRARY SERVICES. After the date of the enactment of this Act, no Federal agency shall permit smoking within any indoor facility in the United States operated by such agency, directly or by contract, to provide routine or regular kindergarten, elementary, or secondary education or library services to children.

(e) SPECIAL WAIVER.

(1) IN GENERAL. On receipt of an application, the head of the Federal agency may grant a special waiver to a person described in subsection (a) who employs individuals who are members of a labor organization and provide children's services pursuant to a collective bargaining agreement that —

(A) took effect before the date of enactment of this Act; and

(B) includes provisions relating to smoking privileges that are in violation of the requirements of this section.

(2) TERMINATION OF WAIVER. A special waiver granted under this subsection shall terminate on the earlier of —

(A) the first expiration date (after the date of enactment of this Act) of the collective bargaining agreement containing the provisions relating to smoking privileges; or

(B) the date that is 1 year after the date of the enactment of this Act.

(f) CIVIL PENALTIES.

(1) IN GENERAL. Any failure to comply with a prohibition in this section shall be a violation of this section and any person subject to such prohibition who commits such violation, or may be subject to an administrative compliance order, or both, as determined by the Secretary. Each day a violation continues shall constitute a separate violation.

Radon

Background Information

The EPA and other major national and international scientific organizations have concluded that radon is a human carcinogen and a serious public health problem. An individual's risk of developing lung cancer from radon increases with the level of radon, the duration of exposure, and the individual's smoking habits. EPA estimates that 7,000 to 30,000 lung cancer deaths in the United States each year are attributed to radon. Because many people spend much of their time at home, the home is likely to be the most significant source of radon exposure. For most school children and staff, the second largest contributor to their radon exposure is likely to be their school. As a result, EPA recommends that school buildings as well as homes be tested for radon.

Results from a National Survey of Radon Levels in Schools

A nationwide survey of radon levels in schools estimates that 19.3% of U.S. schools, nearly one in five, have at least one frequently occupied ground-contact room with short-term radon levels above the action level of 4 pCi/L (picocuries per liter) — the level at which EPA recommends mitigation. Approximately 73% of these schools will have only five or less school rooms with radon levels above the action level. The other 27% will have six or more such schoolrooms. If your building has a radon problem, it is unlikely that every room in your school will have an elevated radon level. However, testing all frequently-occupied rooms that have contact with the ground is necessary to identify schoolrooms with elevated radon levels.

Guidance for Radon Testing

EPA's document *Radon Measurement in School - Revised Edition* (EPA 402-R-92-014) provides guidance on planning, implementing, and evaluating a radon testing program for a school. To assist schools with testing, helpful aids such as a checklist of the testing procedure have been included in this document. However, before initiating radon testing in your school, contact your State Radon Office (see ***Resources,*** **Appendix I**) for information on any State requirements concerning radon testing, or for a copy of this document.

To reduce the health risk associated with radon, EPA recommends that officials test every school for elevated radon levels. Because the entry and movement of radon in buildings is difficult to predict, officials should test all frequently occupied schoolrooms that are in contact with the ground. If testing identifies schoolrooms with radon levels of 4 pCi/L or greater, officials should reduce the radon levels to below 4 pCi/L using an appropriate mitigation strategy.

Guidance for Radon Mitigation

If you identify a radon problem in your school, EPA has developed guidance on radon mitigation enti-

tled *Reducing Radon in Schools — A Team Approach* (EPA 402-R-94-008) that describes the recommended approach to radon mitigation in schools and provides an overview of the mitigation process to the IAQ coordinator.

For a free copy (limit three copies per request), please call 202-260-2080 or contact your State Radon Office (see **Appendix I**, *Resources*).

Guidance for Radon Prevention in Renovations and New Buildings

EPA's document entitled *Radon Prevention in Design and Construction of Schools and Other Large Buildings* (EPA 625-R-92-016) provides guidance for incorporating radon resistant and/or easy-to-mitigate features into the design of a new school building including design recommendations for HVAC systems. This guidance is useful to school personnel (e.g., school business officials) or architects involved with the new building construction in a school district.

For a free copy (limit three copies per request), contact the Center for Environmental Research Information, US Environmental Protection Agency by phone at (513) 569-7562 or fax at (513) 569-7566. For more than three copies (limit 25 copies per request), write to ORD Publications (G72), 26 West Martin Luther King Drive, Cincinnati, OH 45628. Include your name, address, the documents title, and the EPA number of the document.

Training for Testing and Mitigation

To develop public and private sector capabilities for radon testing and mitigation, EPA has formed four Regional Radon Training Centers (see *Resources*, **Appendix I**). These training centers offer courses on testing and mitigation in school buildings designed to simulate hands-on activities by having participants solve practical problems. Currently, EPA and the Regional Training Centers are developing training for radon testing in a self-instructional format providing school officials with a low-cost option for delivering training to their personnel. Contact your State Radon Office (see *Resources*, **Appendix I**) for information on local training opportunities or on state training requirements.

Testing and Mitigation Costs

Cost for radon testing in a typical school building ranges from $500 to $1,500. The type of measurement device used, the size of the school, and whether testing is performed in-house using school personnel or a measurement contractor will influence testing costs.

If a radon problem is identified, the cost for radon mitigation typically ranges from $3,000 to $30,000 per school. The mitigation strategy, the school building design, the radon concentration in the school room(s), and the number of school rooms that need mitigation influence the cost of mitigating a school. The appropriate mitigation strategy will depend on the school building design and initial levels of radon. Mitigation costs at the high end of the cost range are often associated with a mitigation strategy involving the renovation of a school's heating, ventilation, and air-conditioning (HVAC) system. Although the cost is higher, this strategy has the added benefit of improving ventilation within a school building which contributes to the improvement of indoor air quality.

Moisture, Mold and Mildew

Molds and mildew are fungi that grow on, and sometimes within, objects. They can cause discoloration and odor problems, deteriorate building materials, and lead to health problems such as asthma episodes and allergic reactions in susceptible individuals.

Mold spores are almost always present in outdoor and indoor air, and almost all building surfaces can provide nutrients to support growth. Although cleaning and disinfecting with appropriate cleaners and antimicrobial agents provide protection against mold growth, it is virtually impossible to eliminate all nutrients. If moisture is present, mold will thrive and reproduce. Moisture control is thus an important strategy for reducing mold growth.

Mold growth does not require the presence of standing water; it can occur when high relative humidity or the hygroscopic properties (the tendency to absorb and retain moisture) of building surfaces allow sufficient moisture to accumulate. Relative humidity and the factors that govern it are often misunderstood. This appendix is intended to convey an understanding of the factors that govern relative humidity and to describe common moisture problems and their solutions.

Relative Humidity, Vapor Pressure, and Condensation

Water enters buildings both as a liquid and as a gas (water vapor). Liquid water is introduced intentionally at bathrooms, showers, kitchens, and laundries and accidentally by way of leaks and spills. Some of the water evaporates and joins the water vapor that is exhaled by building occupants as they breathe or that is introduced by humidifiers. Water vapor also moves into the building as part of the air that is mechanically introduced or that infiltrates through openings in the building shell. A lesser amount of water vapor diffuses into the building through the building materials themselves.

The ability of air to hold water vapor decreases as the air temperature falls. If a unit of air contains half of the water vapor it can hold, it is said to be at 50% relative humidity (RH). The relative humidity increases as the air cools and approaches saturation. When air contains all of the water vapor it can hold, it is at 100% RH, and the water vapor condenses, changing from a gas to a liquid. The temperature at which this occurs is referred to as the "dew point."

It is possible to reach 100% RH without changing the air temperature, by increasing the amount of water vapor in the air (the "absolute humidity" or "vapor pressure"). It is also possible to reach 100% RH without changing the amount of water vapor in the air, by lowering the air temperature to the "dew point."

The highest RH in a room is always next to the coldest surface. This is referred to as the "first condensing surface," as it will be

the location where condensation happens first, if the relative humidity of the air next to the surface reaches 100 percent. It is important to understand this when trying to understand why mold is growing on one patch of wall or only along the wall-ceiling joint. It is likely that the surface of the wall is cooler than the room air because there is a void in the insulation or because wind is blowing through cracks in the exterior of the building.

Taking Steps to Reduce Moisture

Mold growth can be reduced if relative humidities near surfaces can be maintained below the dew point. This can be accomplished by: 1) reducing the moisture content (vapor pressure) of the air, 2) increasing air movement at the surface, or 3) increasing the air temperature (either the general space temperature or the temperature at building surfaces).

Either surface temperature or vapor pressure can be the dominant factor in causing a mold problem. A surface temperature-dominated mold problem may not respond very well to increasing ventilation, whereas a vapor pressure-dominated mold problem may not respond well to increasing temperatures. Understanding which factor dominates will help in selecting an effective control strategy.

If the relative humidity near the middle of a room is fairly high (e.g., 50% at 70°F), mold or mildew problems in the room are likely to be vapor pressure-dominated. If the relative humidity near the middle of a room is fairly low (e.g., 30% at 70°F), mold or mildew problems in the room are likely to be surface temperature-dominated.

Surface temperature-dominated mold and mildew can be reduced by increasing the surface temperature using either or both of the following approaches:

- raise the temperature of the air near room surfaces
- raise the thermostat setting
- improve air circulation so that supply air is more effective at heating the room surfaces
- decrease the heat loss from room surfaces
- add insulation
- close cracks in the exterior wall to prevent "wind-washing" (air that enters a wall at one exterior location and exits another exterior location without penetrating into the building)

Vapor pressure-dominated mold and mildew can be reduced by using one or more of the following strategies:

- use source control (e.g., direct venting of moisture-generating activities such as showers to the exterior)
- dilute moisture-laden indoor air with outdoor air at a lower absolute humidity
- dehumidify the indoor air

Note that dilution is only useful as a control strategy during heating periods, when cold outdoor air tends to contain little total moisture. During cooling periods, outdoor air often contains as much moisture as indoor air.

Consider an old, leaky, poorly insulated building in Maine that has mold and mildew in the corners of the living room. It is winter, and cold air cannot hold much water vapor. Therefore, outdoor air entering through leaks in the building lowers the airborne moisture levels indoors. This is an example of a surface temperature-dominated mold problem. In this building, increasing the outdoor air ventilation rate is probably not an effective way to control interior mold and mildew. A better strategy would be to increase surface temperatures by insulating the exterior walls, thereby reducing relative humidities next to the wall surfaces.

Consider a school locker room that has mold and mildew on the ceiling. The locker room exhaust fan is broken, and the relative humidity in the room is 60% at 70°F. This is an example of a vapor pressure-dominated mold problem. In this case, increasing the surface temperature is probably not an effective way to correct the mold problem. A better strategy is to repair or replace the exhaust fan.

Identifying and Correcting Common Examples of Mold and Mildew

Exterior Corners

The interior surfaces of exterior corners are common locations for mold and mildew growth in heating climates. They tend to be closer to the outdoor temperature than other parts of the building surface for one or more of the following reasons:

- poor indoor air circulation
- wind-washing

- low insulation levels
- greater surface area of heat loss

Sometimes mold and mildew growth can be reduced by removing obstructions to airflow (e.g., rearranging furniture). Buildings with forced air heating systems and/or room ceiling fans tend to have fewer mold and mildew problems than buildings with less air movement, other factors being equal.

Set Back Thermostats

Set back thermostats are commonly used to reduce energy consumption during the heating season. Mold and mildew growth can occur when temperatures are lowered in buildings with high relative humidity. (Maintaining a room at too low a temperature can have the same effect as a set back thermostat.) Mold and mildew can often be controlled in heating climate locations by increasing interior temperatures during heating periods. Unfortunately, this also increases energy consumption and reduces relative humidity in the breathing zone, which can create discomfort.

Air Conditioned Spaces

The problems of mold and mildew can be as extensive in cooling climates as in heating climates. The same principles apply: either surfaces are too cold, moisture levels are too high, or both.

One common example of mold growth in cooling climates can be found in rooms where conditioned "cold" air blows against the interior surface of an exterior wall. This condition, which may be due to poor duct design, diffuser location, or diffuser performance, creates a cold spot at the interior finish surfaces, possibly allowing moisture to condense.

Possible solutions for this problem include:

- eliminate the cold spots (i.e., elevate the temperature of the surface) by relocating ducts and diffusers
- increase the room temperature to avoid overcooling. NOTE: During the cooling season, increasing temperature decreases energy consumption, though it could cause comfort problems.

Mold problems can also occur within the wall cavity as outdoor air comes in contact with the cavity side of the cooled interior surface. It is a particular problem in rooms decorated with low maintenance interior finishes (e.g., impermeable wall coverings such as vinyl wallpaper) which can trap moisture between the interior finish and the gypsum board. Mold growth can be rampant when these interior finishes are coupled with cold spots and exterior moisture. In a similar case, building investigators realized that soil air was being drawn into the block cores of a masonry wall when they observed condensation on the glass door of a fire alarm.

Possible solutions for this problem include:

- prevent hot, humid exterior air from contacting the cold interior finish (i.e., controlling the vapor pressure at the surface)
- ensure that vapor barriers, facing sealants, and insulation are properly specified, installed, and maintained

Thermal Bridges

Localized cooling of surfaces commonly occurs as a result of "thermal bridges," elements of the building structure that are highly conductive of heat (e.g., steel studs in exterior frame walls, uninsulated window lintels, and the edges of concrete floor slabs). Dust particles sometimes mark the locations of thermal bridges, because dust tends to adhere to cold spots.

The use of insulating sheathings significantly reduces the impact of thermal bridges in building envelopes.

Windows

In winter, windows are typically the coldest surfaces in a room. The interior surface of a window is often the first condensing surface in a room.

Condensation on window surfaces has historically been controlled by using storm windows or "insulated glass" (e.g., double-glazed windows or selective surface gas-filled windows) to raise interior surface temperatures. In older building enclosures with less advanced glazing systems, visible condensation on the windows often alerted occupants to the need for ventilation to flush out interior moisture, so they opened the windows.

The advent of higher performance glazing systems has led to a greater incidence of moisture problems in heating climate building enclosures, because the buildings can now be operated at higher interior vapor pressures (moisture levels) without visible surface condensation on windows.

Concealed Condensation

The use of thermal insulation in wall cavities increases interior surface temperatures in heating climates, reducing the likelihood of interior surface mold, mildew and condensation. However, the use of thermal insulation without a properly installed air barrier may increase moisture condensation within the wall cavity. The first condensing surface in a wall cavity in a heating climate is typically the inner surface of the exterior sheathing.

Concealed condensation can be controlled by either or both of the following strategies:

- reducing the entry of moisture into the wall cavities (e.g., by controlling infiltration and/or exfiltration of moisture-laden air)
- elevating the temperature of the first condensing surface
- in heating climate locations: installing exterior insulation (assuming that no significant wind-washing is occurring)
- in cooling climate locations: installing insulating sheathing to the interior of the wall framing and between the wall framing and the interior gypsum board

Resources

This Appendix lists organizations with information or services related to indoor air quality. In addition, the Appendix includes a section on indoor air quality related publications. Following is a listing of the subsections contained in this Appendix.

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Federal Agencies With Major Indoor Air Responsibilities For Public and Commercial Buildings

U.S. Environmental Protection Agency conducts a non-regulatory indoor air quality program that emphasizes research, information dissemination, technical guidance, and training. EPA issues regulations and carries out other activities that affect indoor air quality under the laws for pesticides, toxic substances, and drinking water.

Indoor Air Quality
Information Clearinghouse
P.O. Box 37133
Washington, DC 20013-7133
Toll Free: 1-800-438-4318
Local: 202-484-1307
Fax: 202-484-1510

Information specialists are on duty Monday - Friday 9:00 am to 5:00 pm eastern time. Provides indoor air quality information and publications.

Occupational Safety and Health Administration promulgates safety and health standards, facilitates training and consultation, and enforces regulations to ensure that workers are provided with safe and healthful working conditions. (For further information contact OSHA Regional Offices.)

National Institute for Occupational Safety and Health conducts research, recommends standards to the U.S. Department of Labor, and conducts training on various issues including indoor air quality to promote safe and healthful workplaces. Undertakes investigations at request of employees, employers, other federal agencies, and state and local agencies to identify and mitigate workplace problems.

Requests for Field Investigations:
NIOSH
Hazard Evaluations and Technical Assistance Branch (R-9)
4676 Columbia Parkway
Cincinnati, OH 45226
513-841-4382

Requests for Information:
1-800-35-NIOSH or
1-800-356-4674

EPA Regional Offices

Address inquiries to the contacts in the EPA Regional Offices at the following addresses:

(CT,ME,MA,NH,RI,VT)
EPA Region 1
John F. Kennedy Federal Building
Boston, MA 02203
617-565-4502 (indoor air)
617-565-4502 (radon)
617-565-3932 (asbestos)

(NJ,NY,PR,VI)
EPA Region 2
290 Broadway
New York, NY 10007-1866
212-637-4013 (indoor air)
212-637-4013 (radon)
908-321-6769 (asbestos)

(DC,DE,MD,PA,VA,WV)
EPA Region 3
841 Chestnut Building
Philadelphia, PA 19107
215-597-8322 (indoor air)
215-597-4553 (radon)
215-597-1970 (asbestos)

(AL,FL,GA,KY,MS,NC,SC,TN)
EPA Region 4
345 Courtland Street, NE
Atlanta, GA 30365
404-347-2864 (indoor air)
404-347-3907 (radon)
404-347-5014 (asbestos)

(IL,IN,MI,MN,OH,WI)
EPA Region 5
77 W. Jackson Boulevard
Chicago, IL 60604
Region 5 Environmental Hotline:
1-800-621-8431
312-353-2000 (outside Region 5)
312-353-5779 (indoor air, radon)
312-353-2212 (asbestos)

(AR,LA,NM,OK, TX)
EPA Region 6
1445 Ross Avenue
Dallas, TX 75202-2733
214-665-7223 (indoor air)
214-665-7223 (radon)
214-665-7223 (asbestos)

(IA,KS,MO,NE)
EPA Region 7
726 Minnesota Avenue
Kansas City, KS 66101
913-551-7020 (indoor air)
913-551-7020 (radon)
913-551-7020 (asbestos)

(CO,MT,ND,SD,UT,WY)

EPA Region 8
999 18th Street, Suite 500
Denver, CO 80202-2466
303-293-1440 (indoor air, radon)
303-293-0989 (asbestos)

(AZ,CA,HI,NV,AS,GU)
EPA Region 9
75 Hawthorne Street, A-1-1
San Francisco, CA 94105
415-744-1132 (indoor air)
415-744-1045 (radon)
415-744-1136 (asbestos)

(AK,ID,OR,WA)
EPA Region 10
1200 Sixth Avenue
Seattle, WA 98101
206-553-2589 (indoor air, radon)
206-553-8282 (asbestos)

OSHA Regional Offices

(CT,ME,MA,NH,RI,VT)
OSHA Region 1
133 Portland Street, 1st Floor
Boston, MA 02114
617-565-7164

(NJ,NY,PR,VI)
OSHA Region 2
201 Varick Street, Room 670
New York, NY 10014
212-337-2376

(DC,DE,MD,PA,VA,WV)
OSHA Region 3
Gateway Building, Suite 2100
3535 Market Street
Philadelphia, PA 19104
215-596-1201

(AL,FL,GA,KY,MS,NC,SC,TN)
OSHA Region 4
1375 Peachtree Street, NE
Suite 587
Atlanta, GA 30367
404-347-3573

(IL,IN,MI,MN,OH,WI)

OSHA Region 5
230 South Dearborn Street
Suite 3244
Chicago, IL 60604
312-353-2220

(AR,LA,NM,OK,TX)
OSHA Region 6
525 Griffin Street, Room 602
Dallas, TX 75202
214-767-4731

(IA,KS,MO,NE)
OSHA Region 7
911 Walnut Street, Room 406
Kansas City, MO 64106
816-426-5861

(CO,MT,ND,SD,UT,WY)
OSHA Region 8
Federal Building, Room 1576
1961 Stout Street
Denver, CO 80294
303-391-5858

(AZ,CA,HI,NV,AS,GU)
OSHA Region 9
71 Stevenson Street, Suite 420
San Francisco, CA 94105
415-744-6670

(AK,ID,OR,WA)
OSHA Region 10
1111 Third Avenue, Suite 715
Seattle, WA 98101-3212
206-553-5930

Other Federal Agencies with Indoor Air Responsibilities

Bonneville Power Administration
P.O. Box 3621-RMRD
Portland, OR 97208
503-230-5475
Provides radon-resistant construction techniques, source control, and removal technology for indoor air pollutants.

Consumer Product Safety Commission
4330 East-West Hwy., Room 502
Bethesda, MD 20814
1-800-638-CPSC
Reviews complaints regarding the safety of consumer products and takes action to ensure product safety.

General Services Administration
18th and F Streets, NW
Washington, DC 20405
202-501-1464
Writes indoor air quality policy for Federal buildings. Provides proactive indoor air quality building assessments. Assesses complaints and provides remedial action.

National Heart, Lung, & Blood Institute Information Center
P.O. Box 30105
Bethesda, MD 20824-0150
301-251-1222
Fax 301-251-1223

Provides information and materials regarding asthma education and prevention

U.S. Department of Energy
Energy Efficiency and Renewable Energy
1000 Independence Avenue, SW
Washington, DC 20585
202-586-9220
Quantifies the relationship among infiltration, ventilation, and acceptable indoor air quality.

U.S. Department of Health and Human Services
Office on Smoking and Health
4770 Buford Highway, NE
Mail Stop K50
Atlanta, GA 30341
404-488-5705
Disseminates information about the health effects of passive smoke and strategies for reducing exposure to environmental tobacco smoke.

Tennessee Valley Authority
Occupational Hygiene Dept.
328 Multipurpose Building
Muscle Shoals, AL 35660-1010
205-386-2314
Provides building surveys and assessments associated with employee indoor air quality complaints.

State and Local Agencies

Your questions and concerns about indoor air problems can frequently be answered most readily by the government agencies in your State or locality. Responsibilities for indoor air quality issues are usually divided among many different agencies. You will often find that calling or writing the agencies responsible for health or air quality control is the best way to start getting information from your State or local government. Contact the IAQ Information Clearinghouse, 1-800-438-4318, for State agency contacts.

BEST COPY AVAILABLE

Building Management Associations

Association of Physical Plant Administrators of Universities and Colleges
1446 Duke Street
Alexandria, VA 22314-3492
703-684-1446

Professional and Standard Setting Organizations

American Academy of Allergy and Immunology
611 East Wells Street
Milwaukee, WI 53202
414-272-6071

Air and Waste Management Association
1 Gateway Center, 3rd Floor
Pittsburgh, PA 15222
412-232-3444

Air-Conditioning and Refrigeration Institute
1501 Wilson Blvd., Suite 600
Arlington, VA 22209
703-524-8800

American Conference of Governmental Industrial Hygienists
1330 Kemper Meadow Drive
Cincinnati, OH 45240
513-742-2020

American Industrial Hygiene Association
2700 Prosperity Avenue
Suite 250
Fairfax, VA 22031
703-849-8888

American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103
215-299-5571

American Society of Heating, Refrigerating, and Air-Conditioning Engineers
1791 Tullie Circle, NE
Atlanta, GA 30329
404-636-8400

Center for Safety in the Arts
5 Beekman Street, Room 820
New York, NY 10038
212-227-6220
The Center has a list of products that are safe for children from grades K-6. The list is provided for a nominal charge.

Art and Craft Materials Institute
100 Boylston Street, Suite 1050
Boston, MA 02116
617-426-6400
Conducts a certification program to ensure nontoxicity (or proper labelling) and quality of products. Works to develop and maintain chronic hazard labelling standard for art and craft materials.

National Conference of States on Building Codes and Standards, Inc.
505 Huntmar Park Drive
Suite 210
Herndon, VA 22070
703-437-0100

Product Manufacturer Associations

Adhesive and Sealant Council
1627 K Street, NW, Suite 1000
Washington, DC 20006-1707
202-452-1500

Asbestos Information Association
1745 Jefferson Davis Hwy.
Room 406
Arlington, VA 22202
703-412-1150

Business Council on Indoor Air
2000 L Street, NW
Washington, DC 20036
202-775-5887

Carpet and Rug Institute
310 Holiday Avenue
Dalton, GA 30720
706-278-3176

Chemical Specialties Manufacturers Association
1913 I Street, NW
Washington, DC 20006
202-872-8110

Electric Power Research Institute
P.O. Box 10412
Palo Alto, CA 94303
415-855-2902

Formaldehyde Institute, Inc.
1330 Connecticut Avenue, NW
Suite 300
Washington, DC 20036
202-659-0060

Foundation of Wall and Ceiling Industries
307 East Annandale Road
Suite 200
Falls Church, VA 22042
703-534-1703

Gas Research Institute
8600 West Bryn Mawr Avenue
Chicago, IL 60631
312-399-8100

National Paint and Coatings Association
1500 Rhode Island Avenue, NW
Washington, DC 20005
202-462-6272

North American Insulation Manufacturer's Association
44 Canal Center Plaza, Suite 310
Alexandria, VA 22314
703-684-0084

Total Indoor Environmental Quality Coalition
1440 New York Avenue, NW
Suite 300
Washington, DC 20005
202-638-1200
Fax 202-639-8685

Building Service Associations

Air-Conditioning and Refrigeration Institute
4301 North Fairfax Drive
Arlington, VA 22203
703-524-8800

Air-Conditioning Contractors of America
1513 16th Street, NW
Washington DC 20036
202-483-9370

American Consulting Engineers Council
1015 15th Street, NW, Suite 802
Washington, DC 20005
202-347-7474

Associated Air Balance Council
1518 K Street, NW, Suite 503
Washington, DC 20005
202-737-0202

Association of Energy Engineers
4025 Pleasantdale Rd., Suite 420
Atlanta, GA 30340
404-447-5083

Association of Specialists in Cleaning and Restoration Intl.
10830 Annapolis Junction Road, Suite 312
Annapolis Junction, MD 20701
301-604-4411

National Air Duct Cleaners Association
1518 K Street, NW, Suite 503Washington, DC 20005
202-737-2926

National Association of Power Engineers
3436 Haines Way, Suite 101
Falls Church, VA 22041
703-845-7055

National Energy Management Institute
601 North Fairfax St., Suite 160
Alexandria, VA 22314
703-739-7100

National Environmental Balancing Bureau
1385 Piccard Drive
Rockville, MD 20850
301-977-3698

National Pest Control Association
8100 Oak Street
Dunn Loring, VA 22027
703-573-8330

Sheet Metal and Air Conditioning Contractors National Association
P.O. Box 221230
Chantilly, VA 22022
703-803-2980

Unions

American Federation of Teachers
555 New Jersey Avenue, NW
Washington, DC 20001
202-879-4400

American Association of Classified School Employees
PO Box 640
San Jose, CA 95106
408-473-0839

National Education Association
1201 16th Street, NW
Washington, DC 20036
202-833-4000

National Association of School Nurses
PO Box 1300
Scarborough, ME 04070-1300
207-883-2117

Environmental/Health/ Consumer Organizations

American Lung Association
or your local lung association
1740 Broadway
New York, NY 10019
212-315-8700

Consumer Federation of America
1424 16th Street, NW, Suite 604
Washington, DC 20036
202-387-6121

National Environmental Health Association
720 South Colorado Blvd.
South Tower, Suite 970
Denver, CO 80222
303-756-9090

Occupational Health Foundation
815 16th Street, NW, Room 312
Washington, DC 20006
202-842-7840

MCS-Related Organizations

Human Ecology Action League (HEAL)
P.O. Box 49126
Atlanta, GA 30359
404-248-1898

National Center for Environmental Health Strategies
1100 Rural Avenue
Voorhees, NJ 08043
609-429-5358

National Foundation for the Chemically Hypersensitive
P.O. Box 222
Ophelia, VA 22530
517-697-3989

Organizations Offering Training on Indoor Air Quality

A calendar of EPA training events is available through the IAQ Information Clearinghouse.

Also, note Regional Radon Training Centers on page 88.

American Industrial Hygiene Association
2700 Prosperity Avenue, Suite 250
Fairfax, VA 22031
703-849-8888
Sponsors indoor air quality courses in conjunction with meetings for AIHA members only.

American Society of Heating, Refrigerating, and Air-Conditioning Engineers
1791 Tullie Circle NE
Atlanta, GA 30329
404-636-8400
Sponsors professional development seminars on indoor air quality.

Mid-Atlantic Environmental Hygiene Resource Center
University City Science Center
3624 Market Street, 1st Floor East
Philadelphia, PA 19104
215-387-2255

NIOSH
Division of Training and Manpower Development
4676 Columbia Parkway
Cincinnati, OH 45226
513-533-8221
Provide training to occupational safety and health professionals and paraprofessionals.

OSHA Training Institute
155 Times Drive
Des Plaines, IL 60018
708-297-4913
Provides courses to assist health and safety professionals in evaluating indoor air quality.

Radon

State Radon Offices

For information, call the radon contact in the EPA Regional Office for your state, or call IAQ INFO.

Regional Radon Training Centers

EPA has coordinated the formation of four Regional Radon Training Centers (RRTCs). The RRTCs provide a range of radon training and proficiency examination courses to the public for a fee.

Eastern Regional Radon Training Center (ERRTC)
Rutgers University
Radiation Science Department
Kilmer Campus, Bldg. 4087
New Brunswick, NJ 08903-0231
908-445-2582

Midwest Universities Radon Consortium (MURC)
University of Minnesota
1985 Buford Avenue (240)
St. Paul, MN 55108-6136
612-624-8747

Western Regional Radon Training Center (WRRTC)
Dept. of Industrial Sciences
Colorado State University
Fort Collins, CO 80523
1-800-462-7459/303-491-7742

Southern Regional Radon Training Center (SRRTC)
Auburn University
107 Ramsey Hall
Engineering Extension Service
Auburn University, AL 36849
205-844-5718

EPA Regional Offices

If you need additional information, start with the EPA Regional Offices listed on page 84. If information is unavailable from the Regional Offices, please contact the EPA Radon Division at:

Radon Division (6604J)
U.S. EPA
401 M Street, SW
Washington, DC 20460
202-233-9370

Other EPA Contacts and Programs of Interest

Asbestos and Small Business Ombudsman
1-800-368-5888
Provides information on asbestos.

National Lead Information Center
1-800-424-5323
Provides information on lead, lead contamination, and lead hazards.

National Pesticides Telecommunications Network
1-800-858-7378
In Texas: 806-743-3091
Provides information on pesticides, hazards and risks.

RCRA/Superfund/EPCRA Hotline
1-800-424-9346

Safe Drinking Water Hotline
1-800-426-4791
Provides information on lead in drinking water.

Stratospheric Ozone Information Hotline 1-800-296-1996
Provides information on chlorofluorocarbons (CFCs).

TSCA Hotline Service
1-202-554-1404
Provides information on asbestos and other toxic substances.

Publications

Items marked * are available from IAQ INFO, the Indoor Air Quality Information Clearinghouse, PO Box 37133, Washington, DC 20013-7133, 1-800-438-4318

Items marked ** are available from TSCA Assistance Hotline (TS-799), 401 M Street, SW, Washington, DC 20460
202-554-1404

Items marked *** are available from NIOSH Publications Dissemination, 4676 Columbia Parkway, Cincinnati, OH 45202
513-533-8287

General Information

Building Air Quality: A Guide for Building Owners and Facility Managers. U.S. Environmental

Protection Agency and the U.S. Department of Health and Human Services December 1991. Available from Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954

Indoor Air Pollution Control. Thad Godish. 1989. Lewis Publishers, 121 South Main Street, Chelsea, MI 48118

Problem Buildings: Building-Associated Illness and the Sick Building Syndrome. James E. Cone and Michael J. Hodgson, MD, MPH. 1989. From the series "Occupational Medicine: State of the Art Reviews." Hanley & Belfus, Inc., 210 South 13th Street, Philadelphia, PA 19107

Report of the Inter-ministerial Committee on Indoor Air Quality. 1988. G. Rajhans. Contact: G. Rajhans, Health and Safety Support Services Branch, Ministry of Labour, 400 University Avenue, 7th Floor, Toronto, Ontario, Canada M7A 1T7

Indoor Air Quality

Introduction to Indoor Air Quality: A Self-Paced Learning Module. National Environmental Health Association and U.S. Environmental Protection Agency. June 1991. Introduces environmental health professionals to the information needed to recognize, evaluate, and control indoor air quality problems.

Introduction to Indoor Air Quality: A Reference Manual. National Environmental Health Association, U.S. Public Health Service and U.S. Environmental Protection Agency. June 1991. Companion document to the *Learning Module*. Provides reference material on selected indoor air quality topics.

Indoor Air Pollution: An Introduction for Health Professionals. The American Lung Association, American Medical Association, U.S. Consumer Product Safety Commission and U.S. Environmental Protection Agency. Manual assists health professionals in diagnosing symptoms that may be related to an indoor air pollution problem.

Managing Asthma: A Guide for Schools. Available from NHLBI, P.O. Box 30105, Bethesda, MD 20824. Pub. 91-2650. Other asthma-related materials also available.

Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA). 1988. 8224 Old Courthouse Road, Vienna, VA 22180

*Project Summaries: Indoor Air Quality in Public Buildings.** U.S. Environmental Protection Agency. 1988. Contains findings of research on IAQ in 10 new public and commercial buildings and on building material emissions.

*The Inside Story: A Guide to Indoor Air Quality.** U.S. Environmental Protection Agency and the U.S. Consumer Product Safety Commission. 1988. Addresses residential indoor air quality primarily, but contains a section on offices.

*Sick Building Syndrome. Indoor Air Quality Fact Sheet #4.** U.S. Environmental Protection Agency. Revised, 1991.

*Ventilation and Air Quality in Offices. Indoor Air Quality Fact Sheet #3.** U.S. Environmental Protection Agency. Revised, 1990.

Air Quality Guidelines for Europe. World Health Organization. 1987. WHO Regional Publications, European Series No. 23. Available from WHO Publications Center USA, 49 Sheridan Avenue, Albany, NY 12210

Radon

State Proficiency Report. U.S. Environmental Protection Agency. 1991. EPA 520/1-94-014. Available from State radon offices. List of laboratories that have demonstrated competence in radon measurement analysis.

Radon Measurements in Schools - Revised edition. U.S. Environmental Protection Agency. 1992. EPA 402/R-92-014.

Radon Measurement in Schools: Self-Paced Training Workbook. U.S. Environmental Protection Agency. 1994. EPA 402/B-94-001.

Reducing Radon in Schools: A Team Approach. U.S. Environmental Protection Agency. 1994. EPA 402/R-94-008.

Radon Prevention in the Design and Construction of Schools and Other Large Buildings, with Addendum. U.S. Environmental Protection Agency. June 1994. EPA 625/R-92-078.

Environmental Tobacco Smoke

Secondhand Smoke: What You Can Do About Secondhand Smoke as Parents, Decisionmakers, and Building Occupants. U.S. Environmental Protection Agency. July 1993. A useful brochure describing the health implications of secondhand smoke and ways to avoid its risks.

Respiratory Health Effects of Passive Smoking fact sheet. U.S. Environmental Protection Agency. January 1993.

Setting the Record Straight: Secondhand Smoke is a Preventable Health Risk: fact sheet. U.S. Environmental Protection Agency. June 1994. EPA 402-F-94-005.

Environmental Tobacco Smoke: Measuring Exposures and Assessing Health Effects. National Research Council. 1986. National Academy Press. 2001 Wisconsin Avenue, NW, Washington, DC 20418

Guidelines for Controlling Environmental Tobacco Smoke In Schools — Technical Bulletin. Ronald Turner, Bruce Lippy, Arthur Wheeler. Februrary 1991. Maryland State Department of Education, Office of Administration and Finance, Office of School Facilities, 200 West Baltimore Street, Baltimore, MD 21201. 410/333-2508

Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders. U.S. Environmental Protection Agency. 1990. EPA/600/6090/006F. EPA's major risk assessment of the health effects of passive smoking (ETS).

The Health Consequences of Involuntary Smoking: A Report of the Surgeon General. U.S. Department of Health and Human Services. Public Health Service. Office on Smoking and Health. 1986. 1600 Clifton Road, NE (Mail Stop K50) Atlanta, GA 30333

Current Intelligence Bulletin 54: Environmental Tobacco Smoke in the Workplace — Lung Cancer and Other Health Effects. *** U.S. Department of Health and Human Services, Public Health Service. Centers for Disease Control, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 91-108. 1991.

A series of one-page information sheets on all aspects of smoking in the workplace. U.S. Department of Health and Human Services, National Cancer Institute. Office of Cancer Communications. For copies, call 1-800-4-CANCER.

Asbestos

A Guide to Monitoring Airborne Asbestos in Buildings. Dale L. Keyes and Jean Chesson. 1989. Environmental Sciences, Inc., 105 E. Speedway Blvd., Tucson, Arizona 85705.

Testimony of NIOSH on the Occupational Safety and Health Administration's Proposed Rule on Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite. U.S. Department of Health and Human Services, Public Health Service, U.S. Centers for Disease Control, National Institute of Occupational Safety and Health. June 1984, May 1990, and January 1991. NIOSH Docket Office, C-34, 4676 Columbia Parkway, Cincinnati, OH 45226

A Guide to Respiratory Protection for the Asbestos Abatement Industry. ** U.S. Environmental Protection Agency. 1986. EPA 560/OTS 86-001.

Abatement of Asbestos-Containing Pipe Insulation. ** U.S. Environmental Protection Agency. 1986. Technical Bulletin No. 1986-2.

Asbestos Abatement Projects: Worker Protection. 40 CFR Part 763. ** U.S. Environmental Protection Agency. February 1987.

Asbestos Ban and Phaseout Rule. 40 CFR Parts 763.160 to 763.179.** U.S. Environmental Protection Agency. Federal Register, July 12, 1989.

Asbestos in Buildings: Guidance for Service and Maintenance Personnel (English/Spanish). ** U.S. Environmental Protection Agency. 1985. EPA 560/5-85-018. ("Custodial Pamphlet").

Asbestos in Buildings: Simplified Sampling Scheme for Surfacing Materials. ** U.S. Environmental Protection Agency. 1985. 560/5-85-030A. ("Pink Book").

Construction Industry Asbestos Standard. 29 CFR Part 1926.58.

General Industry Asbestos Standard. 29 CFR Part 1910.1001.

Guidance for Controlling Asbestos-Containing Materials in Buildings. ** U.S. Environmental Protection Agency. 1985. EPA 560/5-85-024. ("Purple Book").

Guidelines for Conducting the AHERA TEM Clearance Test to Determine Completion of an Asbestos Abatement Project. ** U.S. Environmental Protection Agency. EPA 560/5-89-001.

Managing Asbestos In Place: A Building Owner's Guide to Operations and Maintenance Programs for Asbestos-Containing Materials. ** U.S. Environmental Protection Agency. 1990. ("Green Book").

Measuring Airborne Asbestos Following An Abatement Action. ** U.S. Environmental Protection Agency. 1985. EPA 600/4-85-049. ("Silver Book").

National Emission Standards for Hazardous Air Pollutants. 40 CFR Part 61. ** U.S. Environmental Protection Agency. April 1984.

Transmission Electron Microscopy Asbestos Laboratories: Quality Assurance Guidelines. ** U.S. Environmental Protection Agency. 1989. EPA 560/5-90-002.

Respiratory Protection Standard. 29 CFR Part 1910.134.

Biologicals

Guidelines for the Assessment of Bioaerosols in the Indoor Environment: American Council of Governmental Industrial Hygienists. 1989. 6500 Glenway Avenue, Building D-7, Cincinnati, OH 45211

Biological Contaminants in Indoor Environments. P. Morey, J. Feeley, and J. Otten. 1990. American Society for Testing and Materials, Publications, 1916 Race Street, Philadelphia, PA 19103

PCBs

A Recommended Standard for Occupational Exposure to Polychlorinated Biphenyls. U.S. Department of Health and Human Services. Public Health Service. Centers for Disease Control. National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 77-225. 1977. Available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161

Current Intelligence Bulletin 45: Polychlorinated Biphenyls—Potential Health Hazards from Electrical Equipment Fires or Failures. U.S. Department of Health And Human Services. Public Health Service. Centers for Disease Control. National Institute of Occupational Safety and Health. DHHS (NIOSH) Publication No. 86-111. 1977. Available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161

Transformers and the Risk of Fire: A Guide for Building Owners. **U.S. Environmental Protection Agency. 1986. OPA/86-001.

Building Management, Investigation, and Remediation

Building Air Quality: A Guide for Building Owners and Facility Managers. U.S. Environmental Protection Agency and the U.S. Department of Health and Human Services December 1991. Available from New Orders, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954

Carpet and Indoor Air Quality in Schools. Maryland Department of Education. October 1993. Maryland State Department of Education, Division of Business Services, School Facilities Branch, 200 West Baltimore Street, Baltimore, MD 21201. 410-333-2508

Guidance for Indoor Air Quality Investigations. *** U.S. Department of Health and Human Services. Public Health Service. Centers for Disease Control. National Institute for Occupational Safety and Health. 1987.

*Indoor Air Quality: Selected References.*** U.S. Department of Health and Human Services. Public Health Service. Centers for Disease Control. National Institute for Occupational Safety and Health. 1989.

Interior Painting and Indoor Air Quality in Schools. Bruce Jacobs, March 1994. Maryland State Department of Education, Division of Business Services, School Facilities Branch, 200 West Baltimore Street, Baltimore, MD 21201. 410-333-2508

Managing Indoor Air Quality. Shirley J. Hansen. 1991. Fairmont Press, 700 Indian Trail, Lilburn, GA 30247

Practical Manual for Good Indoor Air Quality. Hani Bazerghi and Catherine Arnoult. 1989. Quebec Association for Energy Management. 1259 Berri Street, Suite 510, Montreal, Quebec, Canada, H2L 4C7.

Science Laboratories and Indoor Air Quality in Schools. Bruce Jacobs. March 1994. Maryland State Department of Education, Division of Business Services, School Facilities Branch, 200 West Baltimore Street, Baltimore, MD 21201 410-333-2508

The Practitioner's Approach to Indoor Air Quality Investigations. Proceedings of the Indoor Air Quality International Symposium. Donald M. Weekes and Richard B. Gammage. 1989. American Industrial Hygiene Association, P.O. Box 8390, Akron Ohio 44320

Ventilation/Thermal Comfort

ASHRAE materials are available from their Publication Sales Department, 1791 Tullie Circle, NE, Atlanta, GA 30329. 404-636-8400

Air Cleaning Devices for HVAC Supply Systems In Schools. Arthur Wheeler. December 1992.

Guideline for the Commissioning of HVAC Systems. ASHRAE Guideline 1-1989. 1989. Several articles describing ASHRAE Standard 62-1989. *ASHRAE Journal.* October, 1989.

Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter. ASHRAE Standard 52-76. 1976.

Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems. ASHRAE Standard 111-1988

Reducing Emission of Fully Halogenated Chlorofluorocarbon (CFC) Refrigerants in Refrigeration and Air Condition Equipment and Applications. ASHRAE Guideline III-1990. 1990.

Selecting HVAC Systems for Schools. Arthur Wheeler and Walter Kunz, Jr. October 1994. Maryland State Department of Education, Division of Business Services, School Facilities Branch, 200 West Baltimore Street, Baltimore, MD 21201. 410-333-2508

The Ventilation Directory. National Conference of States on Building Codes and Standards, Inc., 505 Huntmar Park Drive, Suite 210, Herndon, VA 22070. 703-481-2020. Summarizes natural, mechanical, and exhaust ventilation requirements of the model codes, ASHRAE standards, and unique State codes.

Thermal Environmental Conditions for Human Occupancy. ASHRAE Standard 55-1992. 1992.

Ventilation for Acceptable Indoor Air Quality. ASHRAE Standard 62-1989. 1989.

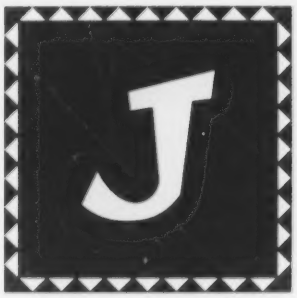
Standards and Guidelines

NIOSH Recommendations for Occupational Safety and Health. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. Compendium of Policy Documents and Statements. DHHS (NIOSH) Publications 91-109. 1991.***

OSHA Standards for Air Contaminants. 29 CFR Part 1910.1000. U.S. Department of Labor. OSHA Regulations. Available from the U.S. Government Printing Office, Washington, DC 20402. 202-783-3238. Additional health standards for some specific air contaminants are also available in Subpart Z.

Threshold Limit Values and Biological Exposure Indices. American Conference of Government Industrial Hygienists. 1990-1991. 6500 Glenway Avenue, Building D-7, Cincinnati, OH 45211

Glossary and Acronyms



AHERA. Asbestos Hazard Emergency Response Act

AHU. See "Air Handling Unit."

ASHRAE. American Society of Heating, Refrigerating, and Air-Conditioning Engineers. See Appendix I: *Resources* for more information.

ASTM. American Society for Testing and Materials. See Appendix I: *Resources* for more information.

Action Packet. Contains three components — an introductory memo, *IAQ Backgrounder,* and IAQ Checklist — to assist school personnel to implement an effective yet simple IAQ program in their school.

Air Cleaning. An IAQ control strategy to remove various airborne particulates and/or gases from the air. The three types of air cleaning most commonly used are particulate filtration, electrostatic precipitation, and gas sorption.

Air Exchange Rate. The rate at which outside air replaces indoor air in a space. Expressed in one of two ways: the number of changes of outside air per unit of time — air changes per hour (ACH); or the rate at which a volume of outside air enters per unit of time — cubic feet per minute (cfm).

Air Handling Unit (AHU). For purposes of this document refers to equipment that includes a blower or fan, heating and/or cooling coils, and related equipment such as controls, condensate drain pans, and air filters. Does not include ductwork, registers or grilles, or boilers and chillers.

Antimicrobial. Agent that kills microbial growth. See "disinfectant," "sanitizer," and "sterilizer."

BRI. See "Building-Related Illness."

Biological Contaminants. Agents derived from, or that are, living organisms (e.g., viruses, bacteria, fungi, and mammal and bird antigens) that can be inhaled and can cause many types of health effects including allergic reactions, respiratory disorders, hypersensitivity diseases, and infectious diseases. Also referred to as "microbiologicals" or "microbials." See Appendix E: *Typical Indoor Air Pollutants* for more information.

Building-Related Illness. Diagnosable illness whose symptoms can be identified and whose cause can be directly attributed to airborne building pollutants (e.g., Legionnaire's disease, hypersensitivity pneumonitis).

Central AHU. See "Central Air Handling Unit."

Central Air Handling Unit. For purposes of this document, this is the same as an Air Handling Unit, but serves more than one area.

CFM. Cubic feet per minute. The amount of air, in cubic feet, that flows through a given space in one minute. 1 CFM equals approximately 2 liters per second (l/s).

CO. Carbon monoxide. See **Appendix E**: *Typical Indoor Air Pollutants* for more information.

CO_2. Carbon dioxide. See **Appendix C**: *IAQ Measuring Equipment*, and **Appendix E**: *Typical Indoor Air Pollutants* for more information.

Conditioned Air. Air that has been heated, cooled, humidified, or dehumidified to maintain an interior space within the "comfort zone." (Sometimes referred to as "tempered" air.)

Dampers. Controls that vary airflow through an air outlet, inlet, or duct. A damper position may be immovable, manually adjustable, or part of an automated control system.

Diffusers and Grilles. Components of the ventilation system that distribute and return air to promote air circulation in the occupied space. As used in this document, supply air enters a space through a diffuser or vent and return air leaves a space through a grille.

Disinfectants. One of three groups of antimicrobials registered by EPA for public health uses. EPA considers an antimicrobial to be a disinfectant when it destroys or irreversibly inactivates infectious or other undesirable organisms, but not necessarily their spores. EPA registers three types of disinfectant products based upon submitted efficacy data: limited, general or broad spectrum, and hospital disinfectant.

Drain Trap. A dip in the drain pipe of sinks, toilets, floor drains, etc., which is designed to stay filled with water, thereby preventing sewer gases from escaping into the room.

EPA. United States Environmental Protection Agency. See **Appendix I**: *Resources* for more information.

ETS. Environmental tobacco smoke. See **Appendix E**: *Typical Indoor Air Pollutants*, **Appendix F**: *Environmental Tobacco Smoke*, and **Appendix I**: *Resources* for more information.

Exhaust Ventilation. Mechanical removal of air from a portion of a building (e.g., piece of equipment, room, or general area).

Flow Hood. Device that easily measures airflow quantity, typically up to 2,500 cfm.

HVAC. Heating, ventilation, and air-conditioning system.

Hypersensitivity Diseases. Diseases characterized by allergic responses to pollutants. The hypersensitivity diseases most clearly associated with indoor air quality are asthma, rhinitis, and hypersensitivity pneumonitis. Hypersensitivity pneumonitis is a rare but serious disease that involves progressive lung damage as long as there is exposure to the causative agent.

IAQ. Indoor air quality.

IAQ Backgrounder. A component of the Action Packet that provides a general introduction to IAQ issues, as well as IAQ program implementation information.

IAQ Coordinator. An individual at the school and/or school district level who provides leadership and coordination of IAQ activities. See **Section 3** for more information.

IAQ Checklist. A component of the Action Packet containing information and suggested easy-to-do activities for school staff to improve or maintain good indoor air quality. Each Activity Guide focuses on topic areas and actions that are targeted to particular school staff (e.g., teachers, administrators, kitchen staff, maintenance staff, etc.) or specific building functions (e.g., HVAC system, roofing, renovation, etc.). The Checklists are to be completed by the staff and returned to the IAQ Coordinator as a record of activities completed and assistance as requested.

IAQ Management Plan. A set of flexible and specific steps for preventing and resolving IAQ problems. See **Section 6** for more information.

IAQ Team. People who have a direct impact on IAQ in the schools (school staff, administrators, school board members, students and parents) and who implement the IAQ Action Packets. See **Section 3** for more information.

IPM. Integrated pest management. See **Appendix D**: *Developing Indoor Air Policies* for more information.

Indoor Air Pollutant. Particles and dust, fibers, mists, bioaerosols, and gases or vapors. See **Section 4** and **Appendix E**: *Typical Indoor Air Pollutants* for more information.

MCS. See "Multiple Chemical Sensitivity."

Make-up Air. See "Outdoor Air Supply."

Microbiologicals. See "Biological Contaminants."

Multiple Chemical Sensitivity. A condition in which a person reports sensitivity or intolerance (as distinct from "allergic") to a number of chemicals and other irritants at very low concentra-

tions. There are different views among medical professionals about the existence, causes, diagnosis, and treatment of this condition.

NIOSH. National Institute for Occupational Safety and Health. See **Appendix I**: *Resources* for more information.

Negative Pressure. Condition that exists when less air is supplied to a space than is exhausted from the space, so the air pressure within that space is less than that in surrounding areas. Under this condition, if an opening exists, air will flow from surrounding areas into the negatively pressurized space.

OSHA. Occupational Safety and Health Administration. See **Appendix I**: *Resources* for more information.

Outdoor Air Supply. Air brought into a building from the outdoors (often through the ventilation system) that has not been previously circulated through the system.

PPM. Parts per million.

Preventive Maintenance. Regular and systematic inspection, cleaning, and replacement of worn parts, materials, and systems. Preventive maintenance helps to prevent parts, material, and systems failure by ensuring that parts, materials and systems are in good working order.

Plenum. Air compartment connected to a duct or ducts.

Pollutant Pathways. Avenues for distribution of pollutants in a building. HVAC systems are the primary pathways in most buildings; however all building components interact to affect how air movement distributes pollutants. See **Section 5** for more information.

Positive Pressure. Condition that exists when more air is supplied to a space than is exhausted, so the air pressure within that space is greater than that in surrounding areas. Under this condition, if an opening exists, air will flow from the positively pressurized space into surrounding areas.

Pressure, Static. In flowing air, the total pressure minus velocity pressure. The portion of the pressure that pushes equally in all directions.

Pressure, Total. In flowing air, the sum of the static pressure and the velocity pressure.

Pressure, Velocity. In flowing air, the pressure due to the velocity and density of the air.

Psychogenic Illness. This syndrome has been defined as a group of symptoms that develop in an individual (or a group of individuals in the same indoor environment) who are under some type of physical or emotional stress. This does not mean that individuals have a psychiatric disorder or that they are imagining symptoms.

Psychosocial Factors. Psychological, organizational, and personal stressors that could produce symptoms similar to those caused by poor indoor air quality.

Radon. A colorless, odorless gas that occurs naturally in almost all soil and rock. Radon migrates through the soil and groundwater and can enter buildings through cracks or other openings in the foundation. Radon can also enter well water. Exposure to radon can cause lung cancer. See **Appendix G**: *Radon* for more information. See **Appendix E**: *Typical Indoor Air Pollutants* for more information.

Re-entry. Situation that occurs when the air being exhausted from a building is immediately brought back into the system through the air intake and other openings in the building envelope.

SBS. See "Sick Building Syndrome."

Sanitizer. One of three groups of anti-microbials registered by EPA for public health uses. EPA considers an antimicrobial to be a sanitizer when it reduces but does not necessarily eliminate all the microorganisms on a treated surface. To be a registered sanitizer, the test results for a product must show a reduction of at least 99.9% in the number of each test microorganism over the parallel control.

Short-circuiting. Situation that occurs when the supply air flows to return or exhaust grilles before entering the breathing zone (area of a room where people are). To avoid short-circuiting, the supply air must be delivered at a temperature and velocity that results in mixing throughout the space.

Sick Building Syndrome. Term sometimes used to describe situations in which building occupants experience acute health and/or comfort effects that appear to be linked to time spent in a particular building, but where no specific illness or cause can be identified. The complaints may be localized in a particular room or zone, or may be spread throughout the building.

Soil Gases. Gases that enter a building from the surrounding ground (e.g., radon, volatile organic compounds, gases from pesticides in the soil).

Sources. Sources of indoor air pollutants. Indoor air pollutants can originate within the building or be drawn in from outdoors. Common sources include people, room furnishings such as carpeting, photocopiers, art supplies, etc. (see Section 5 for more indformation).

Stack Effect. The flow of air that results from warm air rising, creating a positive pressure area at the top of a building and a negative pressure area at the bottom of a building. The stack effect can overpower the mechanical system and disrupt ventilation and circulation in a building.

Sterilizer. One of three groups of anti-microbials registered by EPA for public health uses. EPA considers an antimicrobial to be a sterilizer when it destroys or eliminates all forms of bacteria, fungi, viruses, and their spores. Because spores are considered the most difficult form of a microorganism to destroy, EPA considers the term sporicide to be synonymous with "sterilizer."

TVOCs. Total volatile organic compounds. See "Volatile Organic Compounds (VOCs)"

Unit Ventilator. A fan-coil unit package device for applications in which the use of outdoor- and return-air mixing is intended to satisfy tempering requirements and ventilation needs.

VOCs. See "Volatile Organic Compounds."

Ventilation Air. Defined as the total air, which is a combination of the air brought inside from outdoors and the air that is being recirculated within the building. Sometimes, however, used in reference only to the air brought into the system from the outdoors; this document defines this air as "outdoor air ventilation."

Volatile Organic Compounds (VOCs). Compounds that vaporize (become a gas) at room temperature. Common sources which may emit VOCs into indoor air include housekeeping and maintenance products, and building and furnishing materials. In sufficient quantities, VOCs can cause eye, nose, and throat irritations, headaches, dizziness, visual disorders, memory impairment; some are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans. At present, not much is known about what health effects occur at the levels of VOCs typically found in public and commercial buildings. See **Appendix E**: *Typical Indoor Air Pollutants* for more information.

Zone. The occupied space or group of spaces within a building which has its heating or cooling controlled by a single thermostat.

Index

This Index shows page numbers for the IAQ Coordinator's Guide, the IAQ Backgrounder, and the eight IAQ Checklists.

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Item	IAQ Coordinator's Guide	IAQ Backgrounder	Teacher's Checklist	Administrative Staff Checklist	Health Officer's Checklist	Ventilation Checklist	Building Maintenance Checklist	Food Service Checklist	Waste Management Checklist	Renovation & Repairs Checklist
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Item	IAQ Coordinator's Guide	IAQ Backgrounder	Teacher's Checklist	Administrative Staff Checklist	Health Officer's Checklist	Ventilation Checklist	Building Maintenance Checklist	Food Service Checklist	Waste Management Checklist	Renovation & Repairs Checklist
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Item	IAQ Coordinator's Guide	IAQ Backgrounder	Teacher's Checklist	Administrative Staff Checklist	Health Officer's Checklist	Ventilation Checklist	Building Maintenance Checklist	Food Service Checklist	Waste Management Checklist	Renovation & Repairs Checklist
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Please send information regarding:

- ❑ Training on air quality in schools
- ❑ Radon testing
- ❑ Radon mitigation
- ❑ Radon prevention for new construction
- ❑ Lead-based paints
- ❑ Integrated Pest Management

Name (please print)

Position or Title

School (if you work at the school level)

District (if you work at the district level)

Address

City State Zip

Telephone

We welcome your comments on any aspect of the Indoor Air Quality Tools for Schools Action Kit:

Please send information regarding:

- ❑ Training on air quality in schools
- ❑ Radon testing
- ❑ Radon mitigation
- ❑ Radon prevention for new construction
- ❑ Lead-based paints
- ❑ Integrated Pest Management

Name (please print)

Position or Title

School (if you work at the school level)

District (if you work at the district level)

Address

City State Zip

Telephone

We welcome your comments on any aspect of the Indoor Air Quality Tools for Schools Action Kit:

Indoor Air Quality

Tools for Schools

PLACE
STAMP
HERE

U.S. Environmental Protection Agency
Indoor Air Division, 6607J
401 M Street, SW
Washington D.C. 20460

Indoor Air Quality

Tools for Schools

PLACE
STAMP
HERE

U.S. Environmental Protection Agency
Indoor Air Division, 6607J
401 M Street, SW
Washington D.C. 20460

IAQ Coordinator's Forms

Make copies of the checklists and forms in this section so that the originals will be available for future use. The checklists and forms may be copied or modified according to your specific needs.

The IAQ Backgrounder and IAQ Checklists are individual pieces contained in the IAQ Tools for Schools Action Kit.

- Sample Memo for School Staff
- Sample Memo for Parents
- Sample Memo for Contract Service Providers
- Sample Memo for Local News Media
- Activate the IAQ Management Plan Checklist (2 pages)
- IAQ Coordinator's Checklist (2 pages)
- Checklists Log (1 page)
- Local IAQ Service Providers List (1 page)
- Problem Solving Checklist (4 pages)

Sample Memo for School Staff

Forest Lake School

[Date]

Dear Staff Member:

This month, [Forest Lake] begins a new program to improve indoor air quality in our school. This letter accompanies specific guidance prepared by the U.S. Environmental Protection Agency (EPA) that shows how you can make this program a success.

[Forest Lake] is proud to be taking a leadership role in providing a safe, comfortable, and productive environment for our students and staff so that we achieve our core mission — educating students. Our school will follow the EPA guidance to improve our indoor air quality (IAQ) by preventing as many IAQ problems as possible, and by quickly responding to any IAQ problems that may arise.

Good indoor air quality requires an ongoing commitment by everyone in our school, because each of us daily makes decisions and performs activities that affect the quality of the air we breathe. You can make an important contribution to this IAQ improvement program by reading the background information and applying the simple, yet important, activities in your Checklist, which is attached.

When you have read the IAQ Backgrounder and completed the Checklist, return the Checklist to our IAQ Coordinator, [Name], so that [he or she] can follow up on any unresolved IAQ problems you may have. [Name] has agreed to administer the IAQ Management Plan, which includes taking a team leadership role, coordinating emergency response, and serving as our information resource on IAQ. [Name] may be contacted at [phone and room number]. Please return the Checklist to [him or her] by [date].

The school newsletter will carry progress reports as we learn more about indoor air quality in our school.

Sincerely,

[Name]
[Principal or Superintendent]

Sample Memo for Parents

Forest Lake School

[Date]

Dear [Parent],

This month, [Forest Lake] begins a new program to improve indoor air quality in our school. [Forest Lake] is proud to be taking a leadership role in providing a safe, comfortable, and productive environment for our students and staff so that we achieve our core mission — educating students. Our school will follow U.S. Environmental Protection Agency guidance to improve our indoor air quality (IAQ) by preventing as many IAQ problems as possible, and by quickly responding to any IAQ problems that may arise.

I thought that you would be interested in what we are doing, so with this letter I have enclosed a copy of the IAQ Backgrounder, which is part of the EPA guidance that we are using in our school. Not only is this basic information useful to schools, you may also find it useful for application in your own home, which is where most people spend most of their time.

[Name] has agreed to coordinate the IAQ program for our school. [Name] may be contacted at [phone and room number]. If you have any questions or concerns, please do not hesitate to contact [him or her].

The school newsletter will carry progress reports as we learn more about indoor air quality in our school.

Sincerely,

[Name]
[Principal or Superintendent]

Sample Memo for Contract Service Providers

Forest Lake School

[Date]

Dear [Name of Contract Service Provider]:

[Forest Lake] now has in place a program to monitor and improve indoor air quality in our school. Since the work you will perform in our school can have an impact on the quality of the air within our school, this letter accompanies specific guidance prepared by the U.S. Environmental Protection Agency (EPA) that shows how you can help make this program a success.

[Forest Lake] is proud to be taking a leadership role in providing a safe, comfortable, and productive environment for our students and staff so that we achieve our core mission — educating students. Our school will follow the EPA guidance to improve our indoor air quality (IAQ) by preventing as many IAQ problems as possible.

You can make an important contribution in preventing IAQ problems by reading the IAQ Backgrounder and applying the simple, yet important, activities in your Checklist, which is attached.

If you have any questions or concerns about how your activities may affect the air within our school, please contact me at [phone and room number].

Sincerely,

[Name]
IAQ Coordinator

Sample Memo for Local News Media

Forest Lake School

[Date]

Dear [Local News Media Person]

This month, [Forest Lake] begins a new program to ensure good indoor air quality in our school. [Forest Lake] is proud to be taking a leadership role in providing a safe, comfortable, and productive environment for our students and staff so that we achieve our core mission — educating students. Our school will follow EPA guidance to improve our indoor air quality (IAQ) by preventing as many IAQ problems as possible, and by quickly responding to any IAQ problems that may arise.

As a prominent source of information on events for our local area, you can be helpful in assuring that timely and accurate information regarding IAQ in our school reaches the parents of students and other concerned constituents. I have enclosed a copy of the IAQ Backgrounder, which is one part of a package which the staff in our school has received.

If you have any questions regarding IAQ in our school, please contact our IAQ Coordinator, [Name]. [Name] has agreed to administer the IAQ Management Plan, which includes taking a team leadership role, coordinating emergency response, and serving as our information resource on IAQ. [Name] may be contacted at [phone].

Sincerely,

[Name]
[Principal or Superintendent]

Activating the IAQ Management Plan

IAQ Coordinator | School | Date Completed

Use the checklist below to record and monitor the steps you have taken to activate the IAQ Management Plan.

Steps Taken	Date	Comments/Notes
1. IAQ Coordinator Selected Name:		
2. Guidance Read		
3. Administrative Support Obtained		
4. Requested Additional Information on Radon		
5. Requested Additional Information on Integrated Pest Management		
6. Requested Additional Information on Lead		
7. IAQ Checklist Interval Established # of times each year: Dates:		

Steps Taken	Date	Comments/Notes
8. Emergency Response Prepared		
❑ Local health agency contacted		
❑ IAQ professional(s) identified and contacted		
❑ Equipment and supplies for wet carpets ready or local professional cleaning firm ready		
❑ Local IAQ Service Providers form filled in		
9. Committees and Groups Informed		
❑ Health and safety committee(s)		
❑ Building committee(s)		
❑ PTA		
❑ Others:		
10. IAQ Policies Prepared and Distributed		
❑ Smoking		
❑ Pest control		
❑ Ventilation system operation		
❑ Painting		
❑ Others:		

IAQ Coordinator's Checklist

IAQ Coordinator | School | Date Completed

Use the checklist below to record and monitor the steps you have taken to implement the IAQ Management Plan.

Steps Taken	Date	Comments/Notes
1. Start Action Packets Log		
2. Distribute Action Packets		
❑ All appropriate people have received an Action Packet		
❑ Each Action Packet type has been distributed		
3. Receive and Summarize IAQ Checklists		
❑ Receive all IAQ Checklists		
❑ Review IAQ Checklists		
❑ Transfer data to Checklists Log		
❑ List things to review during walk-through inspection		
4. Perform Walkthrough Inspection		
5. Assess Radon Status		
❑ Testing completed		
❑ Control system installed (if needed)		
❑ Control system properly operating		
6. Assess Pest Control		
7. Assess Lead Status		
8. Identify Recent Changes		
❑ Flooding/water damage		
❑ Night or weekend classes		
❑ New staff		
❑ Other		

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Steps Taken	Date	Comments/Notes
9. Set Repair and Upgrade Priorities		
❑ Make to-do list		
10. Gain Approval for Repairs and Upgrades		
11. Distribute Status Report		
12. Perform Repairs and Upgrades		
13. Conduct Follow-up Inspections		
14. Develop Calendar of IAQ Events		
❑ Set next date for applying IAQ checklist		
❑ Note upcoming renovation and repairs		
❑ Note future addition of staff		
15. Assess Problem Solving Performance		
16. Establish and Update IAQ Policies		
17. Distribute Final Report		
❑ Students and staff		
❑ Parents		
❑ School administration		
18. Check Contacts List		
19. File Checklists, Reports, and Notes		

Checklists Log

IAQ Coordinator _____ School _____

Use this log to keep track of who has received a Checklist, who has returned their Checklist(s), unresolved problem(s) identified in the Checklist(s), who solved the problems, and when.

This log can also be used to record distribution of information to parents, school board members, contract service providers, and local media.

Person Receiving Checklist	Location or Room #	Type of Checklist(s) Distributed: Teachers	Administrative Staff	Health Officer	Ventilation	Building Maintenance	Food Service	Waste Management	Renovation and Repairs	Date Sent	Date Received	Problems Require Follow-up	Follow-up Delegated To	Date Completed
												❑ Yes ❑ No		
												❑ Yes ❑ No		
												❑ Yes ❑ No		

Local IAQ Service Providers List

Hazardous Materials Hotline	FIRM	CONTACT	PHONE	ADDRESS
		TITLE	EMERGENCY	
Local Health Department	FIRM	CONTACT	PHONE	ADDRESS
		TITLE	EMERGENCY	
State Health Department	FIRM	CONTACT	PHONE	ADDRESS
		TITLE	EMERGENCY	
Carpet Cleaner	FIRM	CONTACT	PHONE	ADDRESS
		TITLE	EMERGENCY	
IAQ Consultant	FIRM	CONTACT	PHONE	ADDRESS
		TITLE	EMERGENCY	
Mechanical Systems Operator	FIRM	CONTACT	PHONE	ADDRESS
		TITLE	EMERGENCY	
	FIRM	CONTACT	PHONE	ADDRESS
		TITLE	EMERGENCY	
	FIRM	CONTACT	PHONE	ADDRESS
		TITLE	EMERGENCY	
	FIRM	CONTACT	PHONE	ADDRESS
		TITLE	EMERGENCY	
	FIRM	CONTACT	PHONE	ADDRESS
		TITLE	EMERGENCY	

Problem Solving Checklist

Use this Checklist with the IAQ Problem Solving Wheel to resolve a single IAQ complaint, or several complaints occurring at the same time that seem related. Mark a copy of the fire escape floorplan or use other means of recording and reviewing information. Since this Checklist becomes a record of your activities in resolving an IAQ complaint(s), date it and file it for future reference. Involve additional staff, such as engineers, during the problem solving process.

IAQ Coordinator

School

Complaint Data

Record complaints below at the beginning of your problem solving process. Interview the complainant(s) to get a complete and accurate description of the complaint symptoms, times, and locations.

Complainant Name	Date Received	Description of Complaint (symptoms or explanation)	Location(s) or Room Number(s)	Is Problem Ongoing?	Occurence Date(s) & Time(s)
				❑Y ❑N	
				❑Y ❑N	
				❑Y ❑N	
				❑Y ❑N	
				❑Y ❑N	
				❑Y ❑N	
				❑Y ❑N	
				❑Y ❑N	
				❑Y ❑N	
				❑Y ❑N	

Problem Solving Steps

Follow the directions on the IAQ Problem Solving Wheel to investigate potential causes of the symptoms recorded above. Use the steps below to help keep your investigation organized and documented.

Step	Date Completed	Notes
1. Relate the symptoms from the complaint data box to a group of symptoms in the Notes column to the right		❑ Odors ❑ Temperature or humidity problems (occupant discomfort) ❑ Headache, lethargy, nausea, drowsiness, and dizziness ❑ Swelling, itching, or irritated eyes, nose, or throat; congestion ❑ Cough; congestion; chest tightness; shortness of breath; fever; chills and/or fatigue ❑ Diagnosed infection or clusters of serious health problems

Step	Date Completed	Notes
2. Is this an emergency? ❑ Yes ❑ No See the Wheel sectors "Identifying an emergency" and "What to do in an emergency"		Actions Taken: ❑ Evacuation ❑ Notification ❑ Other:
3. Place a checkmark next to the potential causes in Step 4 below that are shown at 2 on the Wheel.		

4. Each section below corresponds to a section of the IAQ Problem Solving Wheel. Use this area to record diagnostics you perform. Three spaces are provided below for each diagnostic step to allow you to record information for more than one location or piece of equipment. Make extra copies of this form as necessary. Please note that some of the steps may not apply to your building.

Step	Date completed (for each location if more than one location or piece of equipment is involved)			Notes
	1	2	3	
❑ **Temperature & Humidity** ▪ Is thermostat properly set? ▪ Is air flowing from the vent warm (for heat) or cool (for air conditioning)? ▪ Are drafts or direct sunlight causing discomfort? ▪ Is humidity too high or low (best if between 30-60% rel. humidity)? ▪ Is condensation often present on windows or other cold surfaces? ▪ Is there an objectionable odor?				
❑ **Outdoor Air Supply** ▪ Is ventilation system turned on? ▪ Is outdoor intake blocked? ▪ Are supply vent(s) blocked? ▪ Is air flowing from supply vent(s)? ▪ Is air flowing into outdoor intake? ▪ Are outdoor air or supply ducts blocked? ▪ Is outdoor air supply at least 15 cfm per person? ▪ Is CO_2 in the area higher than 1000 ppm?				
❑ **Air Handling Unit** ▪ Is the system turned on? ▪ Is the air flowing from vent(s)? ▪ Is the fan operating? ▪ Is the filter(s) clean & properly installed? ▪ Are dampers operating properly? ▪ Is there moisture, debris or microbial growth in or around the unit? ▪ Is the drain pan clean & draining? ▪ Are the coils clean? ▪ Is combustion equipment properly vented (no flue leaks, spillage, or backdrafting)?				

Step	Date completed (for each location if more than one location or piece of equipment is involved)			Notes
	1	2	3	
❑ **Local Exhaust**				
▪ Does exhaust turn on?				
▪ Is the exhaust used when needed?				
▪ Is air flowing out the exhaust vent?				
▪ Is exhaust duct work blocked?				
▪ Is a sufficient amount of air being exhausted?				
▪ If everything works, but not enough air is being exhausted, can make up air easily enter the room (e.g., through spaces under doors)?				
❑ **Biological Sources**				
▪ Are animals or fungi (mold) present?				
▪ Is there an odor of mold or mildew in or near the complaint area?				
▪ Is there standing water near the complaint area or in the air handling unit?				
▪ Is condensation often present on window or cold surfaces?				
▪ Is indoor relative humidity above 60%?				
▪ Are contagious occupants present?				
❑ **Housekeeping Sources**				
▪ Do complaints occur during or just after housekeeping activities?				
▪ Do housekeeping activities take place near the complainants?				
▪ Are any new products in use?				
▪ Are housekeeping products being used according to directions?				
▪ Are products stored in sealed containers or in a vented room(s)?				
❑ **Outdoor Sources**				
▪ Are sources of odor or pollutants (e.g., vehicles, stored chemicals, trash, plumbing vents) located near outdoor air intakes?				
▪ Are there sources nearby or upwind:				
• Combustion byproducts from traffic, loading docks, or flue exhausts?				
• Industrial, agricultural, or lawn care activity?				
• Construction activity?				
▪ Are pollen levels high?				
❑ **Building Sources**				
▪ Has there been recent painting,roofing, or other remodeling or construction?				
▪ Were pesticides applied recently near the complaint area?				
▪ Are new furnishings or equipment in place?				
▪ Are drain traps dry?				
▪ Are chemicals stored in poorly sealed containers?				
▪ Is it overly dusty?				

Step	Date Completed	Notes
5. Repeat all diagnostics for each potential cause in all affected locations.		
6. If the diagnostics for the recommended potential causes did not identify the problem(s), investigate remaining potential causes in Step 4 until the cause(s) of the complaint(s) are identified and corrected.		
7. If problem remains unidentified or uncorrected, obtain professional assistance.		Company: Person: Phone:
8. Provide notice if problem is not quickly resolved.		❑ Notice to Occupants ❑ Notice to parents of minors
9. Problem resolved and preventive measures taken.		Describe solution: ❑ Preventive measures taken:
10. Provide a final report.		❑ Final report to occupants ❑ Final report to parents of minors
11. To prevent future problems implement an IAQ Management Plan.		
12. File this Checklist and related information.		❑ Done

IAQ Backgrounder

Indoor Air Quality

Tools for Schools

Good indoor air quality contributes to a favorable learning environment for students, productivity for teachers and staff, and a sense of comfort, health, and well-being for all school occupants. These combine to assist a school in its core mission – educating children.

The goal of the Checklist is to provide clear and easily applied activities that you can use to help prevent indoor air quality problems and resolve any problems promptly if they do arise. Once you understand the basic principles and factors that influence indoor air quality in your school, you will note that the specific activities involve two major actions — the management of pollutant sources, and the use of ventilation for pollutant control. This guidance is based on the following principles:

- Many IAQ problems can be prevented by school staff and students
- When IAQ problems do arise, they can often be resolved using the skills of school staff
- The expense and effort required to prevent most IAQ problems is much less than the expense and effort required to resolve problems after they develop

Why IAQ is Important to Your School

Most people are aware that outdoor air pollution can damage their health, but many do not know that indoor air pollution can also have significant harmful effects. U.S. Environmental Protection Agency (EPA) studies of human exposure to air pollutants indicate that indoor levels of pollutants may be 2-5 times, and occasionally more than 100 times, higher than outdoor levels. These levels of indoor air pollutants may be of particular concern because it is estimated that most people spend about 90% of their time indoors. Comparative risk studies performed by EPA and its Science Advisory Board have consistently ranked indoor air pollution among the top five environmental health risks to the public.

Failure to prevent indoor air problems, or failure to respond promptly, can have consequences such as:

- increasing the potential for long term and short term health problems for students and staff
- impacting the student learning environment, comfort, and attendance
- reducing productivity of teachers and staff due to discomfort, sickness, or absenteeism
- accelerating deterioration and reducing efficiency of the school physical plant and equipment
- increasing the potential that schools will have to be closed, or occupants temporarily relocated
- straining relationships among school administration and parents and staff
- creating negative publicity that could damage a school's or administration's image and effectiveness
- creating potential liability problems

Indoor air problems can be subtle and do not always produce easily recognized impacts on health, well-being, or the physical plant. Children may be especially susceptible to air pollution For this and the reasons noted above, air quality in schools is of particular concern — proper maintenance of indoor air is more than a "quality" issue, it encompasses safety and stewardship of our investment in the students, staff, and facilities.

Understanding IAQ Problems and Solutions

Over the past several decades, exposure to indoor air pollutants has increased due to a variety of factors, including the construction of more tightly sealed buildings, reduced ventilation rates to save energy, the use of synthetic build-

ing materials and furnishings, and the use of chemically-formulated personal care products, pesticides, and housekeeping supplies. In addition, our activities and our decisions, such as deferring maintenance to "save" money, lead to problems from sources and ventilation.

Four basic factors affect IAQ: sources of indoor air pollutants, heating, ventilation, and air-conditioning (HVAC) system, pollutant pathways, and occupants.

Sources of Indoor Air Pollutants

Indoor air contaminants can originate within the building or be drawn in from outdoors. If pollutant sources are not controlled, IAQ problems can arise, even if the HVAC system is properly operating. Air pollutants consist of numerous particulates, fibers, mists, bioaerosols, and gases. It may be helpful to think of air pollutant sources as fitting into one of the categories in the table shown below.

In addition to the number of potential pollutants, another complicating factor is that indoor air pollutant concentration levels can vary by time and location within the school building, or even a single classroom. Pollutants can be emitted from point sources, such as from science store rooms, or from area sources, such as newly painted surfaces, and pollutants can vary with time, such as only once each week when floor stripping is done, or continuously such as fungi growing in the HVAC system.

Typical Sources of Indoor Air Pollutants

Outside Sources

Polluted Outdoor Air

- pollen, dust, fungal spores
- industrial emissions
- vehicle emissions

Nearby Sources

- loading docks
- odors from dumpsters
- unsanitary debris or building exhausts near outdoor air intakes

Underground Sources

- radon
- pesticides
- leakage from underground storage tanks

Building Equipment

HVAC Equipment

- microbiological growth in drip pans, ductwork, coils, and humidifiers
- improper venting of combustion products
- dust or debris in ductwork

Non-HVAC Equipment

- emissions from office equipment (volatile organic compounds, ozone)
- emissions from shops, labs, cleaning processes

Components/Furnishings

Components

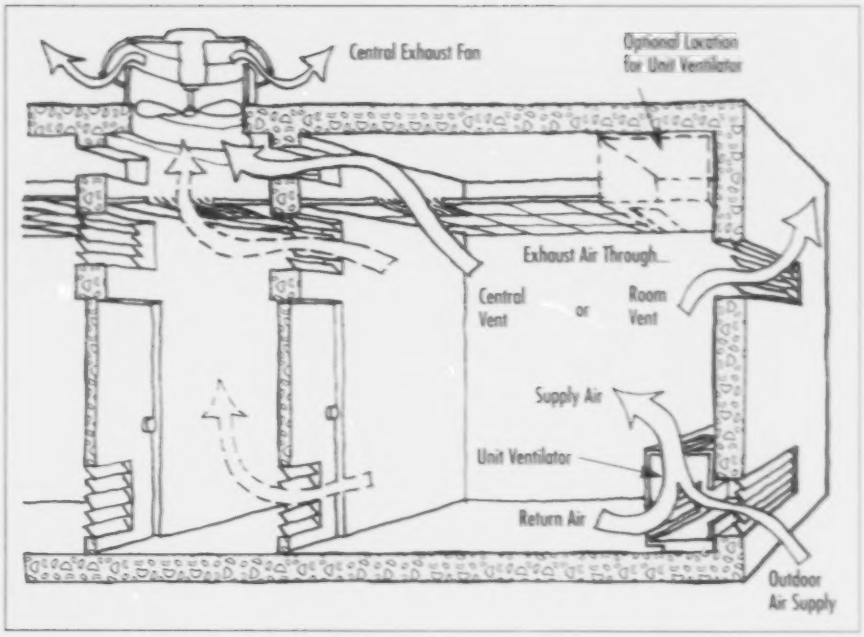
- microbiological growth on soiled or water-damaged materials
- dry traps that allow the passage of sewer gas
- materials containing volatile organic compounds, inorganic compounds, or damaged asbestos
- materials that produce particles (dust)

Furnishings

- emissions from new furnishings and floorings
- microbiological growth on or in soiled or water-damaged furnishings

Other Indoor Sources

- science laboratories
- vocational arts areas
- copy/print areas
- food preparation areas
- smoking lounges
- cleaning materials
- emissions from trash
- pesticides
- odors and volatile organic compounds from paint, caulk, adhesives
- occupants with communicable diseases
- dry-erase markers and similar pens
- insects & other pests
- personal care products



How outdoor air is supplied through a unit ventilator.

HVAC System Design and Operation

The heating, ventilation, and air-conditioning (HVAC) system includes all heating, cooling, and ventilating equipment serving a school. A properly designed and functioning HVAC system:

- controls temperature and humidity to provide thermal comfort
- distributes adequate amounts of outdoor air to meet ventilation needs of school occupants
- isolates and removes odors and pollutants through pressure control, filtration, and exhaust fans

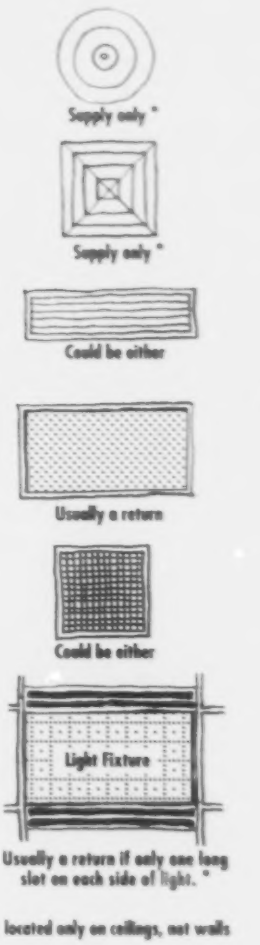
Not all HVAC systems are designed to accomplish all of these functions. Some buildings rely only on natural ventilation. Others lack mechanical cooling equipment, and many function with little or no humidity control. The two most common HVAC designs used in schools are unit ventilators and central air handling systems. Both can perform the same HVAC functions, but the central air handling unit serves multiple rooms while the unit ventilator serves a single room.

The three building figures in this Backgrounder show typical methods for how outdoor air enters a room, and how exhaust air exits through a vent. If exhaust airflow through door or wall grilles into corridors is sealed due to fire codes, ensure that air has another path to reach the central exhaust.

Pollutant Pathways and Driving Forces

Airflow patterns in buildings result from the combined forces of mechanical ventilation systems, human activity, and natural effects. Air pressure differences created by these forces move airborne pollutants from areas of higher pressure to areas of lower pressure through any available openings in building walls, ceilings, floors, doors, windows, and HVAC system. An inflated balloon is an example of this driving force. As long as the opening to the balloon is kept shut, no air will flow, but when open, air will move from inside (area of higher pressure) to the outside (area of lower pressure).

Typical air supply vents and return/exhaust grilles.


Supply only *
Supply only *
Could be either
Usually a return
Could be either
Light Fixture
Usually a return if only one long slot on each side of light. *
* located only on ceilings, not walls

Even if the opening is small, air will move until the pressures inside and outside are equal.

Building Occupants

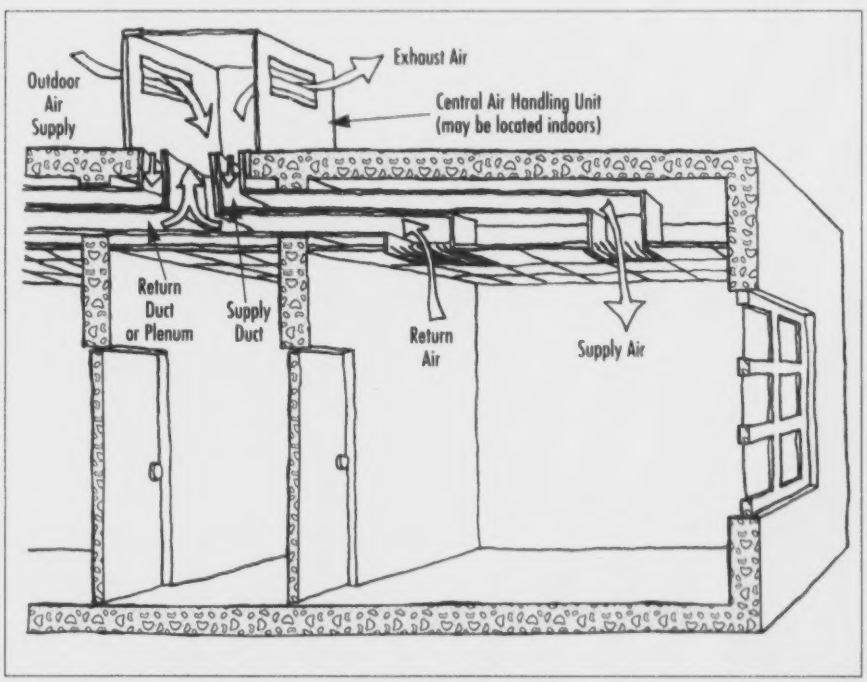
Building occupants in schools include the staff, students, and other people who spend extended periods of time in the school. The effects of IAQ problems on occupants are often non-specific symptoms rather than clearly defined illnesses. Symptoms commonly attributed to IAQ problems include:

- headache, fatigue, and shortness of breath
- sinus congestion, cough, and sneezing
- eye, nose, throat, and skin irritation
- dizziness and nausea

All of these symptoms, however, may also be caused by other factors, and are not necessarily due to air quality deficiencies. Environmental stressors such as improper lighting, noise, vibration, overcrowding, poor ergonomics, and psychosocial problems (such as job or home stress) can produce symptoms that are similar to those associated with poor air quality, but require different solutions.

Because of varying sensitivity among people, one individual may react to a particular IAQ problem while surrounding occupants do not display ill effects. In other cases, complaints may be widespread. In addition to different degrees of reaction, an indoor air pollutant or problem can trigger different types of reactions in different people. Groups that may be particularly susceptible to effects of indoor air contaminants include, but are not limited to:

- allergic or asthmatic individuals, or people with sensitivity to chemicals
- people with respiratory disease
- people whose immune systems are suppressed due to radiation, chemotherapy, or disease
- contact lens wearers



How outdoor air is supplied in a central air handling system.

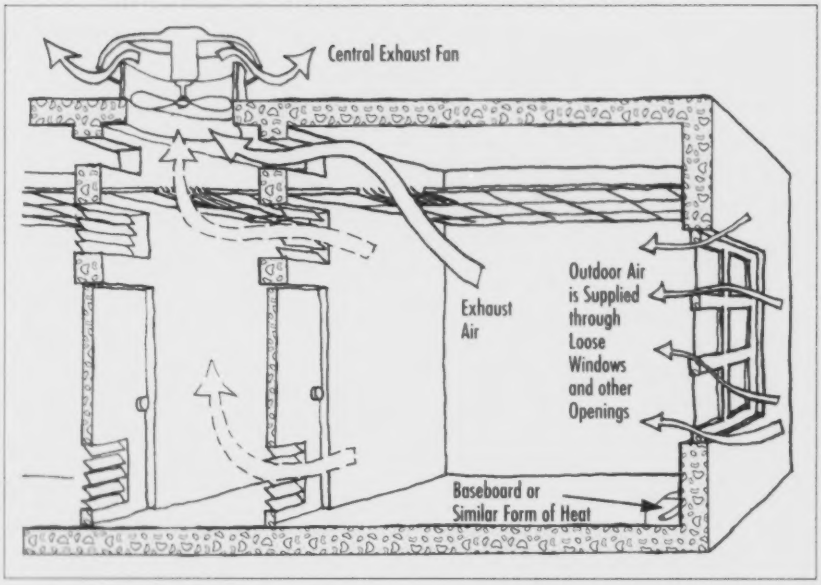
Six Basic Control Strategies

There are six basic control methods for lowering concentrations of indoor air pollutants. Specific applications of these basic control strategies are noted in your Checklists.

Source Management includes source removal, source substitution, and source encapsulation. Source management is the most effective control method when it can be practically applied. Source removal is very effective. However, policies and actions that keep potential pollutants from entering the school are even better at preventing IAQ problems. Examples of source removal include not allowing buses to idle near outdoor air intakes, not placing garbage in rooms with HVAC equipment, and banning smoking within the school. Source substitution includes actions such as selecting a less toxic art material or interior paint than the products which are currently in use. Source encapsulation involves placing a barrier around the source so that it releases fewer pollutants into the indoor air (e.g., asbestos abatement, pressed wood cabinetry with sealed or laminated surfaces).

Local Exhaust is very effective in removing point sources of pollutants before they can disperse into the indoor air by exhausting the contaminated air outside. Well known examples include restrooms and kitchens where local exhaust is used. Other examples of pollutants that originate at specific points and that can be easily exhausted include science lab and housekeeping storage rooms, printing and duplicating rooms, and vocational/industrial areas such as welding booths.

Ventilation through use of cleaner (outdoor) air to dilute the polluted (indoor) air that people are breathing.


Central Exhaust Fan
Exhaust Air
Outdoor Air is Supplied through Loose Windows and other Openings
Baseboard or Similar Form of Heat

How outdoor air is supplied in an exhaust-only system.

Generally, local building codes specify the quantity (and sometimes quality) of outdoor air that must be continuously supplied to an occupied area. For situations such as painting, pesticide application, or chemical spills, temporarily increasing the ventilation can be useful in diluting the concentration of noxious fumes in the air.

Exposure Control includes adjusting the time of use and location of use. An example of time of use would be to strip and wax floors on Friday after school is dismissed, so that the floor products have a chance to off-gas over the weekend, reducing the level of odors or contaminants in the air when the school is occupied. Location of use deals with moving the contaminating source as far as possible from occupants, or relocating susceptible occupants.

Air Cleaning primarily involves the filtration of particles from the air as the air passes through the ventilation equipment. Gaseous contaminants can also be removed, but in most cases this type of system should be engineered on a case-by-case basis.

IAQ Checklists Available

- Teacher's
- Administrative Staff
- Health Officer's
- Ventilation
- Building Maintenance
- Food Service
- Waste Management
- Renovation and Repairs

Education of the school occupants regarding IAQ is critical. If people are provided information about the sources and effects of contaminants under their control, and about the proper operation of the ventilation system, they will better understand their indoor environment and can act to reduce their personal exposure.

Your Role in the IAQ Team

As one of the people in your school, your activities and decisions have an impact on the quality of the indoor air in your school. You can participate by applying the activities noted in your Checklist, and by continuing to apply these principles on a daily basis. Someone from your school or district has taken the role of IAQ Coordinator, and serves as a focal point for collecting IAQ information and handling IAQ concerns.

How Do You Know if You Have an IAQ Problem

Diagnosing symptoms that relate to IAQ can be tricky. Acute (short-term) symptoms of IAQ problems typically are similar to those from colds, allergies, fatigue, or the flu. There are clues that can serve as an indicator of a potential indoor air problem:

- the symptoms are widespread within a class or within the school
- the symptoms disappear when the students or staff leave the school building for a day
- the onset is sudden after some change at school, such as painting or pesticide application
- persons with allergies, asthma, or chemical sensitivities have reactions indoors but not outdoors
- a doctor has found that a student or staff member has an indoor air-related illness

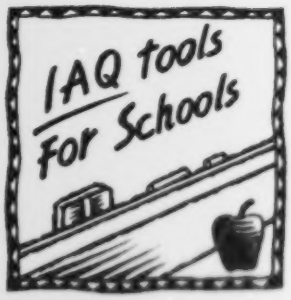
However, a lack of symptoms does not ensure that IAQ is acceptable. Symptoms from long-term health effects (such as lung cancer due to radon) often do not become evident for many years.

What if You Think You Have an IAQ Problem

If you receive complaints that seem to indicate a potential IAQ problem and the problem is self-evident, then attempt to correct the problem. If the problem cannot be corrected, or if the complaint seems to indicate a potentially severe IAQ problem, contact the IAQ Coordinator immediately. The IAQ Coordinator may ask you questions to try to identify whether you have overlooked potential causes of the problem (such as, "Has anything changed since the last time you completed your Checklist?"), and then may call in other help from within or outside the school to investigate further.

Communication

Because indoor air problems can jeopardize the health of students and staff, parents and the public may react strongly to reports of bad indoor air quality in your school. With this in mind, it is recommended that you follow the communications guidelines established by the IAQ Coordinator. Usually, this will involve referring questions from the public and media to one central source, the IAQ Coordinator for your school. In this way, students, parents, staff, and the public will not become alarmed by conflicting or wrong information, and will have a consistent and complete source of information regarding the quality of the indoor air in your school.



This checklist discusses eleven major topic areas:

- General Cleanliness
- Animals in the Classroom
- Drain Traps
- Excess Moisture
- Thermal Comfort
- Ventilation
- Local Exhaust Fans and Fume Hoods
- Art Supplies
- Science Supplies
- Industrial/Vocational Education Supplies
- Locker Room

Instructions:

1. Read the *IAQ Backgrounder*.
2. Check off each box as you complete the activity.
3. Check the triangle(s) as appropriate or check the circle if you need additional help with this activity.
4. Return this checklist to the IAQ Coordinator and keep a copy for future reference.

Name _____

Room or Area _____

School _____

Date Completed _____

Signature _____

Teacher's Checklist

GENERAL CLEANLINESS

Regular and thorough classroom cleaning is important to ensure good indoor air quality. Unsanitary conditions attract insects and vermin, leading to possible indoor air quality (IAQ) problems from animal or insect allergens. The overuse or improper use of pesticides for secondary control of insects, vermin, and head lice can cause IAQ problems. The presence of dirt, moisture, and warmth also stimulate the growth of molds and other microbiological contaminants. While janitors or custodians typically clean the classroom, you can also play an important role in promoting and maintaining classroom cleanliness.

Make sure that the classroom is cleaned properly

❑ Make sure classroom is dusted and vacuumed thoroughly and regularly

❑ Make sure trash is removed daily

❑ Make sure food is not kept in classroom overnight

❑ Store animal food, if any, in tightly sealed containers

❑ Look for signs of pests

❑ Avoid the use of scented cleaners

Δ Classroom cleaned thoroughly and regularly

○ Need help with cleaning or pest control

Clean spills promptly

❑ For spills on carpets, contact custodial staff immediately (carpets need to be cleaned properly, and dried within 24 hours)

❑ Request that unit ventilator be cleaned and filter replaced if spilled liquid goes into the unit

❑ Report previous spills on carpets or in unit ventilators because they can affect current indoor air quality

Δ No spills

○ Need help with cleaning spill

ANIMALS IN THE CLASSROOM

Certain individuals, in particular those with asthma, are sensitive to animal fur, dander, body fluids, and feces and may experience reactions to these allergens. Furthermore, individuals can become sensitized (made allergic) by repeated exposure to animal allergens.

Minimize exposure to animal allergens

❑ Keep animals in cages as much as possible; do not let them roam

❑ Clean cages regularly

❑ Locate animals away from ventilation system vents to avoid circulating allergens throughout the room or building

❑ Use alternatives to animals if possible

Δ No warm-blooded animals in classroom

Δ Exposure to animal allergens minimized

○ Need help minimizing exposure to animal allergens

Take special care with asthmatic or other sensitive students

❑ Consult the school health officer or nurse about student allergies or sensitivities (privacy laws may limit the information that health officials can disclose)

❑ Ask parents about potential allergies in a note that students take home, or during parent teacher conferences

❑ Remember to check for allergies when new students enter the class

❑ Locate sensitive students away from animals and habitats

Δ No animals in classroom

Δ No students have animal allergies

Δ Students with allergies have been identified

○Need help determining if students have allergies

DRAIN TRAPS IN CLASSROOMS

Drain traps, if present, can become a problem when the water in the drain trap evaporates due to infrequent use, allowing sewer gases to enter the room.

Fill drain traps regularly

❑ Pour water down floor drains once per week (approx. 1 quart of water)

❑ Run water in sinks at least once per week (approx. 2 cups of water)

❑ If not regularly used, flush toilets once each week

Δ Drain traps are filled regularly

○Need help filling dry drain traps regularly

EXCESS MOISTURE IN CLASSROOMS

Excess moisture contributes to the growth of mold and mildew which causes odors and other IAQ problems. Excess moisture is the result of condensation on cold surfaces, leaking or spilled liquid, or excess humidity.

Note condensate (condensed water, or "fog") on cold surfaces

❑ Windows, window sills, and window frames

❑ Cold water pipes

❑ Indoor surfaces of exterior walls

Δ No condensate

○Excess condensate found

Check for leaks or signs of moisture from plumbing or roofs

❑ Around and under classroom sinks

❑ In classroom lavatories

❑ On ceiling tiles or walls (discoloration may indicate periodic leaks)

Δ No leaks or signs of moisture

○Found leaks or signs of moisture

THERMAL COMFORT

Temperature and relative humidity can affect comfort and IAQ. Changing thermostat settings or opening windows to try to control temporary fluctuations in temperature can worsen comfort problems and also have an adverse effect on other parts of the school.

Check comfort factors

❑ Temperature (generally 72°F-76°F)

❑ Draftiness

❑ Direct sunlight shining on students

❑ Humidity is too high (typically if higher than 60% relative humidity, RH) or too low (typically if lower than 30% relative humidity)

Δ Room typically comfortable

○Need help, room frequently uncomfortable

VENTILATION

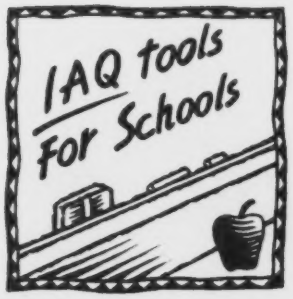
Ventilation is the process by which stale indoor air is exhausted to the outside and outdoor air is drawn into the building. You may either have mechanical ventilation (supplied by fans) or natural ventilation (i.e., operable windows). Improperly operated or poorly maintained ventilation systems may cause IAQ problems. Odors, or the need to use scented air fresheners, may indicate a ventilation problem. The ventilation system can carry air contaminants from another location in the school to your classroom.

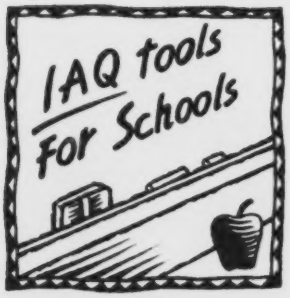
Determine how your classroom is ventilated (see *IAQ Backgrounder*)

❑ Locate unit ventilator (if any)

❑ Locate air supply and air return vents (if any)

❑ Determine whether your windows are operable (if no mechanical ventilation system)





Δ Located the unit ventilator

Δ Located air supply and return vents

Δ Windows are operable

○Need help determining type of ventilation

If you have mechanical ventilation, confirm that air is flowing into the room from the air supply vent(s)

❑ Check for airflow by holding a strip of lightweight plastic or piece of tissue paper near the air supply vent(s); if air is flowing, the plastic or tissue will flutter away from the supply vent

❑ Make sure that the airflow is not diverted or obstructed by books, papers, furniture, curtains, or other obstacles. Never place anything on top of unit ventilators

Δ No problem, air is flowing without obstruction

○No air supply

If you have mechanical ventilation, confirm that air is flowing from the room into the air return grille(s)

❑ Check for airflow at air return grille(s) in the same manner as with previous activity. If air is flowing, the plastic or tissue will be pulled toward the return. Alternatively, a piece of plastic that nearly covers the grille will stick to the face of the grille if air is flowing

❑ Make sure that the airflow is not obstructed by books, papers, furniture, curtains, or other obstacles

Δ No problem, air is flowing without obstruction

○Need help, air is not flowing

Check for unexplained odors

❑ Vehicle exhaust

❑ Kitchen/food

❑ "Chemical" smell

❑ Mold or mildew

Δ No problem with odors in classroom

Δ Found source of odors and corrected problem

○Need help, sometimes smell unexplained odors in classroom

NOTE: Conduct the following activities as appropriate to your classroom.

LOCAL EXHAUST FANS AND FUME HOODS

Local exhaust fans and fume hoods can be used to prevent air pollutants from accumulating in, or spreading beyond, the local area or classroom. Local exhaust fans may be used to exhaust entire rooms (e.g., bathrooms or locker rooms). Fume hoods are appropriate for activities that generate significant quantities of pollutants in a local area within a room (e.g., science experiments, spray painting, and welding).

Determine if your classroom activities generate air pollutants and whether your classroom is equipped with local exhaust fans and/or fume hoods

❑ If there are no activities that generate air pollutants, you do not need a local exhaust fan or fume hood

Δ No major pollutant generating activities

Δ Have fume hood and/or exhaust fan

○Need fume hood and/or local exhaust fan

Confirm that fume hoods and local exhaust fans function properly

❑ Check for air flow when fans are on (hold a piece of tissue paper near the fan — or within the space of the fume hood — to see whether it is pulled away from the room)

❑ Fume hoods are not cracked, broken, or pulling away from the ceiling or wall

❑ Fan is not operated due to noise

❑ No odors in adjacent rooms or halls

Δ Fans function; no odors in adjacent areas

Δ Fume hood is in good repair

○Need help, hood or exhaust fan does not appear to function properly

Confirm that fume hoods and fans are used whenever activities that generate pollutants take place

❑ Train students and others who use the classroom or equipment on when and how to use the fume hoods and fans

❑ Conduct pollutant generating activities under the fume hood with exhaust fan turned on

❑ Monitor use throughout the year

Δ Fans and fume hoods are used properly

○Fans and fume hoods are not used properly

ART SUPPLIES

Art supplies may emit contaminants during use and storage. In addition, certain activities (e.g., firing ceramic kilns) may generate air contaminants or heat up the classroom, causing thermal discomfort to occupants. Although potentially toxic supplies have appropriate labeling since a 1990 federal law took effect, it is still up to teachers to see that safety precautions are followed. Examples of art supplies and activities that may contribute to IAQ problems include:

- Solvents
- Inks
- Adhesives and glues
- Wax
- Varnishes and lacquers
- Powdered pigments
- Acids
- Clays
- Paints
- Firing kilns

Learn about your supplies

❑ Check to see whether your supplies (noted above) are listed as toxic or nontoxic by the Art and Craft Materials Institute or the Center for Safety in the Arts. Supplies that are nontoxic will be labeled AP Nontoxic, CP Nontoxic, or Health Label (without warning conditions) by the Art and Craft Materials Institute

❑ Read labels and identify precautions regarding fumes or ventilation

Δ Supplies okay

○Need help inventorying supplies or interpreting label warnings

If you make purchase decisions, or recommend products for purchase, confirm that supplies are safe to use

❑ Choose art supplies approved as safe by the Art and Craft Materials Institute or the Center for Safety in the Arts. Lists of safer products are available from both organizations (Art and Craft Materials Institute, 5 Beekman St., New York, NY 10038; Center for Safety in the Arts, 100 Boylston St., Suite 1050, Boston, MA 02116)

Δ Supplies are safe to use

○Need help determining if supplies are safe

Follow good safety, handling, and storage practices

❑ Have appropriate procedures and supplies available for spill control

❑ Label all hazardous supplies with date of receipt/preparation and pertinent precautionary information

❑ Tightly seal containers

❑ Follow recommended procedures for disposal of used substances

❑ Secure compressed gas cylinders

❑ Supply storage areas should be separate from classroom and ventilated

Δ Following good handling and storage practices

○Need help developing good safety, handling, or storage practices

Minimize exposure to hazardous materials

❑ Substitute less- or nonhazardous materials where possible

❑ Use local exhaust fans

❑ Isolate contaminant producing activities or operations

❑ Use moist-premixed rather than powdered products

❑ Use techniques that require the least amount of materials

Δ **Exposure minimized**

○ **Need help minimizing exposure to art supplies**

SCIENCE SUPPLIES

Some supplies used as teaching aids in science laboratories may contribute to IAQ problems. Science experiments should be conducted in well ventilated rooms using fume hoods and local exhaust systems wherever appropriate. Basic safety precautions can prevent spills or other mishaps that cause air contamination, and should be followed at all times. Examples of science supplies that may contribute to IAQ problems include:

- Solvents
- Acids
- Flammables
- Caustics
- Biologics
- Compressed gases

Learn about your supplies

❑ Read labels and identify precautions regarding fumes ventilation

❑ Request information and Material Safety Data Sheets from suppliers and manufacturers

Δ **Supplies reviewed**

○ **Need help determining impacts of supplies**

Follow good safety, handling, and storage practices

❑ Obtain guidance documents:

- *School Science Laboratories: A Guide To Some Hazardous Substances*, 1984 Council of State Science Supervisors and U.S. CPSC, 800-638-2772 (800-492-8104 in MD) U.S. GPO #1984-421-506/3308
- *Manual of Safety & Health Hazards In The School Science Laboratory*, 1980 NIOSH/U.S. Department of Health & Human Services, National Technical Information Service, 703-487-4650, # PB-85-238-228

❑ Have appropriate procedures developed and supplies available for spill control (i.e., absorbant materials to control the spread of spills)

❑ Label all chemicals accurately with date of receipt/preparation and pertinent precautionary information

❑ Store supplies according to manufacturers' recommendations

❑ Follow recommended procedures for disposal of used substances

❑ Secure compressed gas cylinders

❑ Storage areas should be separate from main classroom area and ventilated separately

Δ **Following good safety, handling, and storage practices**

○ **Need help developing good safety, handling, or storage practices**

Minimize exposure to hazardous materials

❑ Use diluted substances rather than concentrates wherever possible

❑ Use techniques that require the least quantity of hazardous materials

❑ Ensure that fume hoods capture respirable particles, gases, and vapors released within them

❑ Confirm that exhaust fans operate

Δ **Exposure minimized**

○ **Need help minimizing exposure to supplies**

INDUSTRIAL/VOCATIONAL EDUCATION SUPPLIES

Industrial and vocational education materials and operations can create IAQ problems. Examples of the kinds of activities and supplies that may contribute to IAQ problems include:

- Machining
- Solvents
- Grinding
- Fuels
- Painting
- Soldering
- Welding
- Baking/heating
- Adhesives

Learn about your supplies

❑ Read labels and identify precautions regarding fumes or ventilation

❑ Request information and Material Safety Data Sheets from suppliers and manufacturers

Δ Supplies reviewed

○ Need help determining impacts of industrial/vocational supplies

Follow good safety, handling, and storage practices

❑ Develop appropriate procedures and have supplies available for spill control (e.g., absorbant materials to control the spread of spills)

❑ Store supplies according to manufacturers' recommendations

❑ Follow recommended procedures for disposal of used substances

❑ Secure compressed gas cylinders

❑ Storage areas should be separate from classroom and ventilated

Δ Following good safety, handling, and storage practices

○ Need help developing good safety, handling, or storage practices

Minimize exposure to hazardous materials

❑ Use instructional techniques that require the least quantity of materials

❑ Ensure that fume hoods capture all respirable particles, gases, and vapors released within them

❑ Confirm that exhaust fans operate

Δ Exposure minimized

○ Need help minimizing exposure to materials

LOCKER ROOM

Locker room conditions that affect indoor air quality include: standing water, high humidity, warm temperatures, and damp or dirty clothing. In addition, some of the methods necessary to control germs and odors in the locker room (e.g., use of disinfectants) may themselves contribute to indoor air quality problems if used improperly (e.g., if sprayed into the air instead of directly onto surfaces).

Verify that showers and other locker room areas are cleaned regularly and properly

❑ Use chemical cleaners and disinfectants when areas are unoccupied

❑ Run exhaust fans to remove moisture and odors

Δ Locker room and showers cleaned regularly and properly

○ Need help to have showers and locker room cleaned regularly and properly

Maintain cleanliness and reduce excess moisture in the locker room

❑ Remove wet towels regularly

❑ Wash and dry soiled practice uniforms regularly

❑ Encourage students to take soiled clothes home regularly

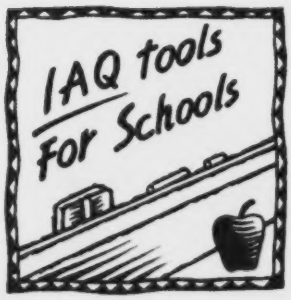
❑ Operate exhaust fans to remove moisture

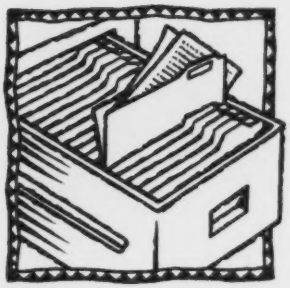
Δ Soiled clothes and towels are removed regularly

○ Need help to have soiled clothes or towels removed regularly

NO PROBLEMS TO REPORT

❑ I have completed all activities on this Checklist, and I do not need help in any areas





Administrative Staff Checklist

This checklist discusses seven major topic areas:

- General Cleanliness
- Drain Traps
- Excess Moisture
- Thermal Comfort
- Local Exhaust Fans
- Ventilation
- Printing and Duplicating Equipment

Instructions:

1. Read the *IAQ Backgrounder.*
2. Check off each box as you complete the activity.
3. Check the triangle(s) as appropriate or check the circle if you need additional help with this activity.
4. Return this checklist to the IAQ Coordinator and keep a copy for future reference.

Name _____

Room or Area _____

School _____

Date Completed _____

Signature _____

GENERAL CLEANLINESS

Regular and thorough cleaning is important to ensure good indoor air quality. Unsanitary conditions attract insects and vermin, leading to possible indoor air quality (IAQ) problems from animal or insect allergens or pesticide use. The presence of dirt, moisture, and warmth also stimulates the growth of molds and other microbiological contaminants. While janitors or custodians typically clean administrative offices, you can also play an important role in promoting and maintaining office cleanliness.

Confirm that the office area is cleaned properly

❑ Make sure that the office is dusted/vacuumed thoroughly and regularly

❑ Make sure that trash is removed daily

❑ Make sure that food is not kept in offices overnight

❑ Look for signs of pests

Δ Office is cleaned thoroughly and properly

○ Need help with office cleaning or pest control

Clean spills promptly

❑ For spills on carpets involving more than a quart of liquid, contact custodial staff immediately (carpets need to be cleaned, dried, and disinfected within 24 hours)

❑ Request that unit ventilator filter be replaced if spilled liquid goes into the unit (see drawing in *IAQ Backgrounder*)

❑ Report previous spills on carpets or in unit ventilators because they can affect current indoor air quality

Δ No significant spills

○ Need help with cleaning spill

DRAIN TRAPS

Drain traps, if present, can become a problem when the water in the drain trap evaporates due to infrequent use, allowing sewer gases to enter the room.

Fill drain traps in your area each week

❑ Pour water down floor drains (approx. 1 quart of water)

❑ Run water in sinks (approx. 2 cups of water)

❑ If not regularly used, flush toilets at least once each week

Δ Drain traps are filled regularly

○ Need help filling drain traps regularly

EXCESS MOISTURE

Excess moisture contributes to the growth of mold and mildew which causes odors and other IAQ problems. Excess moisture is the result of condensation on cold surfaces, leaking or spilled liquid, or excess humidity.

Check for condensate (condensed water, or "fog") on cold surfaces

❑ Window glass, frames or sills

❑ Plumbing (pipes and fixtures)

❑ Inside surfaces of exterior walls

Δ No condensate

○ Excess condensate found

Check for leaks (or signs of wetness) from plumbing or roof

❑ On ceiling tiles and walls (discolored patches may indicate periodic leaks)

❑ Around and under sinks

❑ In lavatories

Δ No leaks or signs of moisture

○ Found leaks or signs of moisture

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THERMAL COMFORT

Temperature and relative humidity can affect comfort and indoor air quality. Changing thermostat settings or opening windows to try to control temporary fluctuations in temperature can worsen comfort problems and also have an adverse effect on other parts of the school. Comfort for all occupants is a worthy objective, but due to various comfort requirements and clothing levels among occupants, a more practical goal is assuring that at least 80% of the occupants are comfortable.

Check comfort factors

❑ Temperature (generally 72° F to 76° F)

❑ Draftiness

❑ Sunlight shining directly on occupants

❑ Humidity is too high (typically if higher than 60% relative humidity, R.H.) or too low (typically if lower than 30% R.H.)

Δ Room typically comfortable

○ Need help, room frequently uncomfortable

LOCAL EXHAUST FANS

Local exhaust fans can be used to prevent air pollutants from accumulating in, or spreading beyond, the local area or room where pollutants are generated. A local exhaust fan can be linked to the operation of a particular piece of equipment (such as a duplicator) or used to treat an entire room (such as a smoking room or custodial closet).

Determine if activities generate air pollutants and whether the room or area is equipped with local exhaust fans

❑ Typical office activities that generate air pollutants include: smoking, operation of some office equipment and food preparation and eating

❑ If there are no activities that generate air pollutants, then you do not need a local exhaust fan

❑ Local exhaust fans should be considered for the school nurse's office to help prevent the spread of germs throughout the school

Δ No major pollutant generating activities

Δ Have local exhaust fan(s)

○ Need local exhaust fan(s)

Confirm that local exhaust fans (if any) function properly

❑ Check for air flowing in the proper direction when fans are switched on (use chemical smoke obtained from the IAQ coordinator, or pieces of tissue)

❑ Odorous pollutants seem to be properly removed

❑ Fan is not too noisy to use

Δ Local exhaust fans function

○ Need help evaluating or fixing fan(s)

Confirm that fans are used whenever activities that generate air pollutants take place

❑ Conduct pollutant generating activities only when the exhaust fan(s) is on

Δ Fans are used properly

○ Fans are not used properly

VENTILATION

Ventilation is the process by which stale indoor air is exhausted to the outside and outside air is drawn into the building. Your building may have mechanical and/or natural ventilation (i.e., windows). Improperly operated or poorly maintained ventilation systems may cause IAQ problems. Odors may indicate a ventilation problem. The ventilation system can carry air pollutants from another location in the school to your area.

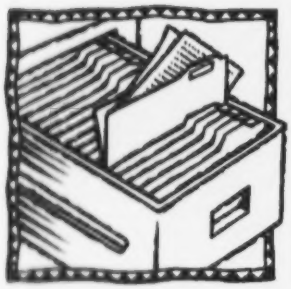
Determine how your office is ventilated

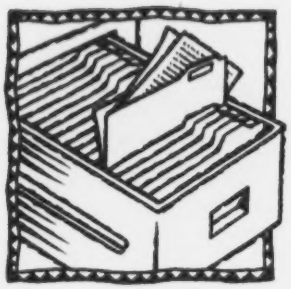
❑ Locate unit ventilators (if any)

❑ Locate air supply and return vents (if any)

❑ Determine whether your windows (if any) are operable

Δ Located the unit ventilator





Δ Located air supply and return vents

Δ Windows are operable

○Need help determining type of ventilation

If you have mechanical ventilation, confirm that air is flowing into the room from the air supply vent(s)

❑ Check for airflow by holding a tissue or strip of lightweight plastic near the air supply vent(s); if air is flowing, the plastic or tissue will flutter away from the supply vent

❑ Make sure that the airflow is not diverted or obstructed by books, papers, furniture, curtains, or other obstacles. Never place anything on top of unit ventilators

Δ No problem, air is flowing without obstruction

○No supply air or need help removing obstruction

If you have mechanical ventilation, confirm that air is flowing from the room into the air return grilles

❑ Check for airflow at air return grilles in the same manner as the previous activity. If air is flowing, the plastic or tissue will be pulled toward the air return grilles. Alternatively, a piece of plastic or tissue that nearly covers the grille will stick to the face of the grilles if air is flowing

❑ Make sure that the airflow is not diverted or obstructed by books, papers, furniture, curtains, etc.

Δ No problem, air is flowing without obstruction

○No exhaust air or need help removing obstruction

Check for unexplained odors

❑ Vehicle exhaust

❑ Kitchen/food

❑ "Chemical"

❑ Mold or mildew

Δ No problem, never detect any odors

○Need help, sometimes smell odors

PRINTING/DUPLICATING EQUIPMENT

Printing and duplicating equipment can generate indoor air pollutants. Common types of duplicating and printing equipment include: photocopiers, spirit duplicating machines, mimeograph machines, diazo dyeline (blueprint) machines, electronic stencil makers and computer (laser) printers. Spirit duplicating machines and diazo dyeline (blueprint) machines present particular IAQ problems due to the presence of methyl alcohol and ammonia, respectively. Local exhaust and ventilation is important (see the previous activities).

Confirm that the equipment functions properly

❑ Equipment does not leak

❑ No odors detected

❑ Equipment is regularly maintained

❑ No complaints from individuals who are exposed to the equipment

Δ Equipment functions properly

○Need help determining whether equipment functions properly

Minimize staff and student exposure to equipment

❑ Equipment is located in a well ventilated area with sufficient outdoor air

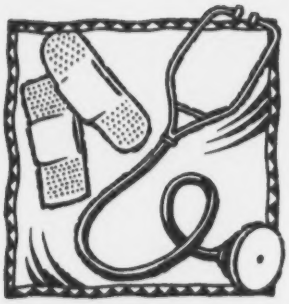
❑ Spirit duplicating equipment and diazo dyeline copiers should be located in separate room with a fan to exhaust air to the outside

Δ Equipment is located in well ventilated area or separate room with appropriate local exhaust

○Need help moving equipment or minimizing exposure

NO PROBLEMS TO REPORT

❑ I have completed all activities on the Checklist and I do not need help in any areas



Health Officer's Checklist

This checklist discusses three major topic areas:

- Maintain Student Health Records
- Public Health and Personal Hygiene Education
- Health Officer's Office

Instructions:

1. Read the *IAQ Backgrounder.*
2. Check off each box as you complete the activity.
3. Check the triangle(s) as appropriate or check the circle if you need additional help with this activity.
4. Return this checklist to the IAQ Coordinator and keep a copy for future reference.

Name _____

School _____

Date Completed _____

Signature _____

MAINTAIN STUDENT HEALTH RECORDS

There is evidence to suggest that children, pregnant women, and senior citizens are more likely to develop health problems from poor air quality than most adults. Indoor Air Quality (IAQ) problems are most likely to affect those with preexisting health conditions and those who are exposed to tobacco smoke. Student health records should include information about known allergies and other medically documented conditions, such as asthma, as well as any reported sensitivity to chemicals. Privacy considerations may limit the student health information that can be disclosed, but to the extent possible, information about students' potential sensitivity to IAQ problems should be provided to teachers. This is especially true for classes involving potential irritants (e.g., gaseous or particle emissions from art, science, industrial/vocational education sources). Health records and records of health-related complaints by students and staff are useful for evaluating potential IAQ-related complaints.

Include information about sensitivities to IAQ problems in student health records

❑ Allergies, including reports of chemical sensitivities

❑ Asthma

Δ Complete health records exist for each student

Δ Health records are being updated

○ Need help obtaining information about student allergies and other health factors

Track health-related complaints by students and staff

❑ Keep a log of health complaints that notes the symptoms, location and time of symptom onset, and exposure to pollutant sources

❑ Watch for trends in health complaints, especially in timing or location of complaints

Δ Have a comprehensive health complaint logging system

Δ Developing a comprehensive health complaint logging system

○ Need help developing a comprehensive health complaint logging system

Recognize indicators that health problems may be IAQ-related

❑ Complaints are associated with particular times of the day or week

❑ Other occupants in the same area experience similar problems

❑ The problem abates or ceases, either immediately or gradually, when an occupant leaves the building and recurs when the occupant returns

❑ The school has recently been renovated or refurnished

❑ The occupant has recently started working with new or different materials or equipment

❑ New cleaning or pesticide products or practices have been introduced into the school

❑ Smoking is allowed in the school

❑ A new warm-blooded animal has been introduced into the classroom

Δ Understand indicators of IAQ-related problems

○ Need help understanding indicators of IAQ-related problems

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HEALTH AND HYGIENE EDUCATION

Schools are unique buildings from a public health perspective because they accommodate more people within a smaller area than most buildings. This proximity increases the potential for airborne contaminants (germs, odors, and constituents of personal products) to pass between students. Raising awareness about the effects of their habits on the well-being of others can help reduce IAQ-related problems.

Obtain *Indoor Air Quality: An Introduction for Health Professionals*

❑ Contact your EPA Regional Office (See Appendix I, *Resources*)

❑ Contact IAQInfo, 800-438-4318

Δ Have this EPA guidance document

Δ Guide is on order

○ Cannot obtain the guide

Inform students and staff about the importance of good hygiene in preventing the spread of airborne contagious diseases

❑ Provide written materials to students (local public health agencies may have information suitable for older students)

❑ Provide individual instruction/counseling where necessary

Δ Written materials and counseling available

Δ Compiling information for counseling and distribution

○ Need help compiling information or implementing counseling program

Provide information about IAQ and health

❑ Help teachers develop activities that reduce exposure to indoor air pollutants for students with IAQ sensitivities, such as those with asthma or allergies (contact the American Lung Association [ALA])

❑ Collaborate with the PTA to offer family IAQ education programs

❑ Conduct a teacher workshop on health issues that covers IAQ

Δ Have provided information to parents and staff

Δ Developing information and education programs for parents and staff

○ Need help developing information and education program for parents and staff

Establish an information and counseling program regarding smoking

❑ Provide free literature on smoking and environmental tobacco smoke

❑ Sponsor a quit smoking program and similar counseling programs in collaboration with the ALA

Δ "No Smoking" information and programs in place

Δ "No Smoking" information and programs in planning

○ Need help with a "No Smoking" program

HEALTH OFFICER'S OFFICE

Since the health office may be frequented by sick students and staff, it is important to take steps that can help prevent transmission of airborne diseases to uninfected students and staff (see your IAQ Coordinator for help with the following activities).

Ensure that the ventilation system is properly operating

❑ The ventilation system is operated when the area(s) is occupied

❑ Provide an adequate amount of outdoor air to the area(s). There should be at least 25 cubic feet of outdoor air supplied per occupant

❑ Air filters are clean and properly installed

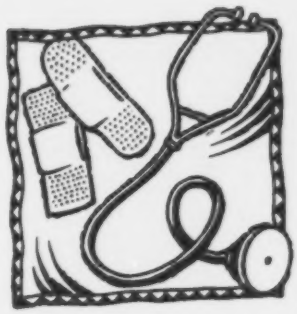
❑ Air removed from the area(s) does not circulate through the ventilation system into other occupied areas

Δ Ventilation system operating adequately

○ Need help with ventilation related activities

NO PROBLEMS TO REPORT

❑ I have completed all activities on this Checklist, and I do not need help in any areas



Ventilation Checklist

This checklist discusses eight major topic areas:

- Outdoor Air Intakes
- System Cleanliness
- System Controls
- Air Distribution
- Exhaust Systems
- Quantity of Outdoor Air
- Adequacy of Outdoor Air Supply
- How to Measure Airflow

Instructions:

1. Read the *IAQ Backgrounder.*
2. Make one copy of the Ventilation Log for each ventilation unit in your school.
3. Complete each activity for each ventilation unit and note the status of each activity on the Ventilation Log.
4. Return the Ventilation Logs to the IAQ Coordinator and keep copies for future reference.

Name _____

School _____

Date Completed _____

Signature _____

Schools use a variety of methods for ventilating the building with outdoor air: 1) mechanically-based systems such as unit ventilators, central HVAC systems, and central exhaust systems, and 2) passive systems that rely on operable windows, air leaks, wind, and the stack effect (the tendency of warm air to rise).

The majority of the Ventilation Checklist activities apply mainly to mechanical ventilation systems, and are designed to accomplish two functions:

- Ensure that the ventilation system is clean, and
- Ensure that an adequate amount of outdoor air is supplied to occupied areas

Many of these activities should be performed by individuals with appropriate training in mechanical systems and safety procedures. Most activities can be performed with basic maintenance tools, but Activity 22 will require airflow measurement equipment that you may not have. The section *How to Measure Airflow*, at the back of this Checklist, describes the type of equipment used to measure airflow. The IAQ Coordinator has information on how this equipment can be obtained (**Appendix C**). Make an effort to obtain this equipment before conducting Activity 17. Supplying an adequate amount of outdoor air to an occupied area is necessary for good indoor air quality, and measuring airflow can only be done correctly with equipment that can reliably tell you if you're getting the proper amount of outdoor air (visual inspection or feeling for air movement is not sufficient).

Activities 17-21 can be applied to passive ventilation systems. For activities that do not apply, place a "NA" in the date column of the Ventilation Log.

Your school most likely has multiple units and systems, so be sure to perform the activities and complete the Ventilation Log for each unit. The activities are listed in a purposeful order to prevent having to repeat activities for a given unit as the inspection progresses. The following is a recommended process for saving time in performing the activities:

Activities 1-3

Perform these activities for all outdoor air intakes while outside the building, and mark the results on the Ventilation Log for each unit.

Activities 4-12

Perform these activities as a set on each ventilation unit while you're in the room and the unit is open.

Activities 13-16

Perform these ventilation control system activities as required by your situation.

Activities 17-21

Perform these air distribution and exhaust system activities as required by your situation.

Activities 22-23

Perform these activities regarding the quantity of outdoor air on all units while you have the airflow measurement equipment available.

OUTDOOR AIR INTAKES

If outdoor air intakes are deliberately blocked or become clogged with dirt or debris, areas they serve are likely to get insufficient outdoor air. Students or staff might experience stuffy or stagnant air, or develop health problems from exposure to accumulated pollutants.

❑ On a small floorplan (e.g., a fire escape floor plan), mark the locations of outdoor air intakes, based on mechanical plans (if available) and your observations while performing these activities

❑ Obtain chemical smoke (or, alternatively, a small piece of tissue paper or light plastic) before performing Activity 3. For more information on chemical smoke, see How to Measure Airflow, at the end of this Checklist and see the IAQ Coordinator for ordering information

❑ Ensure that the ventilation system is on and operating in "occupied" mode

1. Ensure that outdoor air intakes are unobstructed

❑ Check the intakes from outside the school building for obstructions, such as debris, clogged screens, or make-shift covers (e.g., boards or plastic)

❑ Remove any obstructions

❑ Install corrective devices if snowdrifts or leaves often block an intake

2. Ensure that outdoor air intakes are clear of nearby pollutant sources

❑ Check the intakes from outside the school building to confirm that pollutant sources are not located near outdoor air intakes

- At ground level, look for dumpsters, loading docks, and bus idling areas
- At roof level, look for plumbing vents, exhaust outlets (such as kitchen, toilet, or laboratory exhaust fans), puddles on the roof, and mist from air-conditioning cooling towers

❑ Resolve problems due to pollutants near intakes:

- Remove sources, where possible (for example, move a dumpster to another location)
- Separate the source from the intake (for example, add another pipe section to raise a nearby exhaust outlet above the intake)
- Change operating procedures (for example, turn off vehicles instead of idling at loading docks and bus stands)

3. Confirm that outdoor air is entering the system intake

❑ Use chemical smoke (or, alternatively, a small piece of tissue paper or light plastic) to show whether air is moving into the intake grille

SYSTEM CLEANLINESS

Accumulated dirt can interfere with the proper operation of the ventilation system and lead to underventilation, uncomfortable temperatures, less efficient operation (higher utility bills), more maintenance, and decreased life expectancy of equipment. Air filters are intended primarily to prevent dirt and dust from accumulating in the HVAC system. If filters are not properly selected and maintained, built-up dirt in coils and ducts can provide a habitat for microbiological growth. Filters that are clogged with dirt restrict the flow of air through the HVAC system. If filters "blow out" and allow the passage of unfiltered air, dirt can accumulate on coils (producing a need for more frequent cleaning) and reduce the efficiency of the heating and/or cooling plant. It is much less expensive to trap dirt with properly-maintained filters than to remove it from ductwork, coils, fan blades, and other HVAC system components.

WARNING: Do not clean dirty or biologically contaminated system components when the system is operating and the building is occupied.

WARNING: If there is visible biological growth, such as mold, minimize your exposure to air in the interior of ducts or other HVAC equipment unless you are using proper respiratory protection. Obtain expert advice about the kind of respiratory protection to use and how to use it.

4. Inspect air filters on ventilation equipment

❑ Install new filters as needed. Shut off ventilation system fans when replacing associated filters so that dirt will not blow downstream. Vacuum the filter area before installing the new filter

❑ Confirm that filters fit properly in their tracks, with no major air leaks that would allow air to bypass (flow around) the air filter

❑ Confirm that filters are installed in the proper direction for airflow

5. Ensure that condensate drain pans are clean and drain properly

❑ Drain pans should slant toward the drain so they do not collect and hold water

6. Ensure that heating and cooling coils are clean

7. Ensure that air handling unit(s) (air mixing chambers, coils, and fan blades) and duct interiors are clean

8. Ensure that the mechanical rooms are free of trash and chemicals

❑ Check mechanical room for unsanitary conditions, leaks, or spills

❑ Confirm that mechanical rooms and air mixing chambers are not used to store trash or chemical products and supplies

CONTROLS FOR OUTDOOR AIR SUPPLY

This group of activities is for ventilation systems that use fans or blowers to supply outdoor air to one or more rooms within a school. The primary objectives that you should keep in mind as you perform these activities are:

- To ensure that air dampers are always at least partially open (minimum position) during occupied hours, and
- To ensure that the minimum position provides an adequate amount of outdoor air for the occupants

These activities are fairly generic, and apply to most ventilation systems. See the figures in the IAQ Backgrounder for more information.

Activities 9-11 generally serve multiple ventilation units, while activities 12-16 are related and performed at each individual ventilation unit. Based on your equipment and experience, perform as many of the activities and make as many indicated repairs as possible. Discuss the need for additional help for any uncompleted activities or repairs with your IAQ Coordinator.

9. Gather controls information

Your ventilation controls may be uniquely designed, and since there are many different types and brands of control components, it can be very helpful if you:

❑ Gather and read any controls specifications, as-built mechanical drawings, and controls operations manuals that you may have

❑ Contact the system installer or HVAC maintenance contractor to obtain controls information that is missing from your files

10. Check Clocks, Timers, and Seasonal Switches

❑ Confirm that summer-winter switches are in the right position

❑ Confirm that time clocks read the correct time

❑ Confirm that time clock settings fit the actual schedule of building use (night/weekend set-back and set-up)

11. Check pneumatic control system components (if any)

❑ Test the line pressure at both the occupied (day) setting and the unoccupied (night) setting to determine whether the overall system pressure is appropriate

❑ Confirm that the line dryer is preventing moisture buildup

❑ Check the control system filters. The filter at the compressor inlet should be changed periodically in keeping with the compressor manufacturer's recommendation (for example, when you blow down the tank)

❑ Ensure that the line pressure at each thermostat and damper actuator is at the proper level (no leakage or obstructions)

❑ Repair or replace defective components

12. Check outdoor air damper operation

Before continuing, the air temperature in the indoor area(s) served by this outdoor air damper must be within the normal operating range, and ensure that the outdoor air damper is visible for your inspection

❑ Turn off the air handler connected to the outdoor air damper and confirm that the damper fully closes within a few minutes

❑ Turn on the air handler and confirm that the outdoor air damper opens at least partially with little or no delay

❑ Set the room thermostat as follows, and observe the damper for movement (damper should go to its minimum position, but not completely closed):

- If in heating mode, set the room thermostat to 85°F
- If in cooling mode, set the room thermostat to 60°F, mark the current setting of the mixed air thermostat, and set it to a low setting (about 45°F)

❑ If the outdoor air damper does not move:

- Confirm that the damper actuator is linked to the damper shaft and that any linkage set screws or bolts are tight
- Confirm that rust or corrosion are not preventing free movement
- Confirm that either electrical wires or pneumatic tubing is connected to the damper actuator

❑ Reset thermostat(s) to appropriate temperature(s)

❑ Proceed to Activities 13-16 if the damper seems properly operating

NOTE: The minimum damper setting, adjusted with a nut or a knob, may have to be adjusted to allow a larger damper opening if the amount of outdoor air supply measured in Activity 22 is not adequate for the number of occupants being served.

The following four items may be responsible for keeping outdoor air dampers closed during the normal occupied cycle.

13. Confirm freeze-stat condition

HVAC systems with water coils need protection from freezing. The freeze-stat may close the outdoor air damper and disconnect the supply air when tripped. The typical trip range is 35°F to 42°F.

Unit Ventilators are sometimes specified to operate under one of the following ASHRAE sequences:

Cycle I: Except during warm-up stage (outdoor air damper closed), Cycle I supplies 100% outdoor air at all times.

Cycle II: During the heating stage, Cycle II supplies a set minimum quantity of outdoor air. Outdoor air is gradually increased, as required for cooling. During warm-up, the outdoor air damper is closed. (Typical sequence for northern climates.)

Cycle III: During the heating, ventilating and cooling stages, Cycle III supplies a variable amount of outdoor air as required to maintain a fixed temperature (typically 55°F) entering the heating coil. When heat is not required, this air is used for cooling. During warmup, the outdoor air damper is closed. (Typical sequence for southern climates, with adaptions for mechanical cooling.)

- ❑ If the freeze-stat has a manual reset button (usually red), depress the button. If a click is heard, the freeze-stat was probably tripped. Consider replacing manual reset freeze-stats with automatic reset freeze-stats
- ❑ If the freeze-stat has an automatic reset, disconnect power to the controls and test for continuity across the terminals

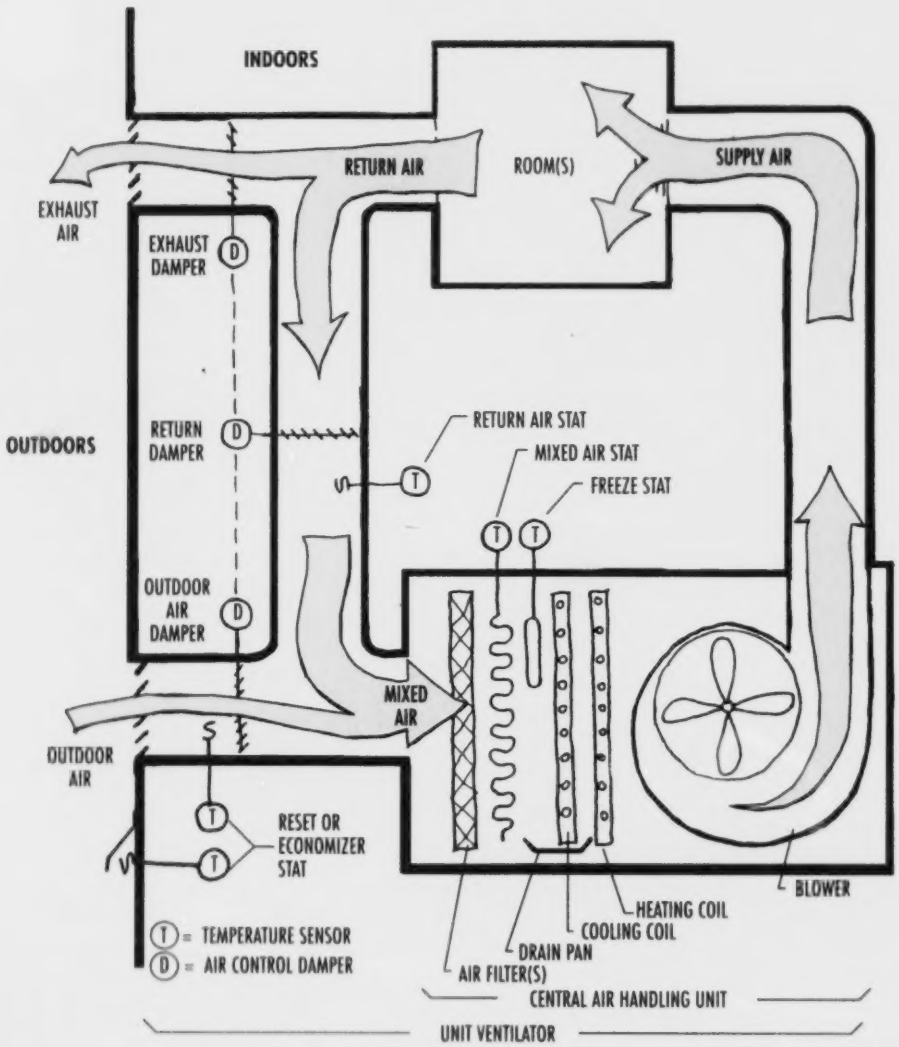
14. Check mixed air thermostat

- ❑ The mixed air stat for heating mode should be set no higher than 65°F
- ❑ The mixed air stat for cooling mode should be set no lower than the room thermostat setting

15. Check air economizer setting

Economizers use varying amounts of cool outdoor air to assist with the cooling load of the room or rooms. There are two types of economizers, dry-bulb and enthalpy. Dry-bulb economizers vary the amount of outdoor air based on outdoor air temperature, and enthalpy economizers vary the amount of outdoor air based on outdoor air temperature and humidity level.

Typical HVAC System Layout



❑ Confirm proper settings based on design specifications or local practices (dry-bulb setting typically 65°F or lower)

❑ Check the sensor to make sure that it is shielded from direct sunlight

16. Confirm that fans operate continuously during occupied periods

Any fan that helps move air from outdoors to indoors must operate continuously during occupied hours, even though the room thermostat is satisfied.

❑ If the fan shuts off when the thermostat is satisfied, change the control cycle to prevent underventilation.

AIR DISTRIBUTION

Even if enough outdoor air is brought into a school building, IAQ problems can develop if the outdoor air is not properly distributed. In such cases, underventilation occurs in particular areas of the building rather than being widespread. Problems with air distribution are most likely to occur in areas where:

- Ventilation equipment is malfunctioning
- Room layouts have been altered without adjusting the HVAC system
- The population of a room or zone has grown without adjustment to the HVAC system

Air pressure differences move air contaminants from outdoors to indoors and transport them within buildings. In schools with mechanical ventilation equipment, fans are the dominant influence on pressure differences and air flows. In schools without mechanical ventilation equipment, natural forces (wind and stack effect) primarily influence airflows.

To prevent infiltration of outdoor air and soil gas (e.g., radon), mechanically-ventilated buildings are often designed to maintain a higher air pressure indoors than outdoors, which is known as positive pressurization (See *Exhaust Systems* and *How to Measure Airflow* for a description of building pressurization). At the same time, exhaust fans control indoor contaminants by keeping rooms such as smoking lounges, bathrooms, kitchens, and laboratories under negative pressure compared to surrounding rooms. "Negative pressure" and "positive pressure" describe pressure relationships. A room can operate under negative pressure as compared to neighboring rooms, but at the same time it may be positive compared to outdoors.

17. Check air distribution

Verify that air pathways in the original ventilation system design continue to function.

❑ Check to see whether operable windows have been replaced by windows that cannot be opened

❑ Check to see whether passive gravity relief ventilation systems and transfer grilles between rooms and corridors are functioning. If they are closed off or blocked to meet modern fire codes, consult with a professional engineer for remedies

❑ Verify that every occupied space has a supply of outdoor air (mechanical system or operable windows)

❑ Confirm that supplies and returns are open and unblocked. If outlets have been blocked intentionally to correct drafts or discomfort, investigate and correct the cause of the discomfort and reopen the vents

❑ If you discovered areas with no source of outside air, modify the HVAC system to correct the problem

❑ Check for barriers, such as room dividers, large free-standing blackboards or displays, or bookshelves, that could block movement of air in the room, especially if they block air vents

18. Check air flow direction

Confirm that the system, including any exhaust fans, is operating on the occupied cycle when doing this activity.

❑ Where outdoor contaminant sources have been identified, use chemical smoke to determine whether the air flows out of the building through leaks in nearby windows, doors, or other cracks and holes in exterior walls

❑ Use chemical smoke to determine whether air flows out of the building through below-grade cracks and holes (e.g., floor joints, pipe openings)

EXHAUST SYSTEMS

Exhaust systems are used to remove air that contains contaminants, including odors. Some HVAC designs also rely on the operation of exhaust fans to create negative pressure that draws outdoor air into the building through windows and gaps in the building envelope.

19. Confirm that exhaust fans are operating

❑ Use chemical smoke to confirm that air is flowing into the exhaust grille(s)

20. Verify that local exhaust fans remove enough air to eliminate odors and chemical fumes

❑ If the fan is intended to exhaust the entire room, stand outside the room with the door slightly open and use chemical smoke to confirm that air is being drawn into the room from locations both high and low in the door opening (see *How to Measure Airflow*)

❑ If the fan is running, but air isn't flowing toward the exhaust intake (or too little air is moving to do the job), check for the following possibilities:

- The backdraft damper at the exhaust outlet does not open
- Obstructions in the ductwork
- Leaky or disconnected ductwork
- Broken fan belt
- Motor running backwards
- Design problems (e.g., undersized fan)

21. If the exhaust fan is located close to the contaminant source, rather than on the roof, and exhaust air is ducted through the building under positive pressure

❑ Confirm that the exhaust ductwork is sealed and in good condition

QUANTITY OF OUTDOOR AIR

22. Measure quantity of outdoor air per person

❑ See *How to Measure Airflow* at the end of this Checklist for techniques on measuring outdoor air supply

❑ Measure the quantity of ***outdoor*** air supplied either to or from each ventilation unit. Use the Ventilation Log to calculate the quantity of outside air per person being provided to occupants (22a. on the Ventilation Log)

❑ Count or calculate the number of occupants served by the ventilation unit under consideration (22b. on the Ventilation Log)

❑ Divide the quantity of outdoor air supplied by the number of occupants served for the ventilation unit under consideration (22a÷22b on the Ventilation Log)

ADEQUACY OF OUTDOOR AIR SUPPLY

23. Compare the measured outdoor air per person to Table 1

- ❑ In the first column of Table 1, find the listing for the type of area that is served by the unit you are evaluating
- ❑ Check the second column to see if the occupancy for each 1,000 square feet that the ventilation unit serves is no greater than the occupancy assumed for the recommendations
- ❑ Compare the recommended ventilation in the third column of Table 1 to the calculated outdoor air per person from Activity 22
- ❑ If the calculated airflow is below the recommendations in Table 1, it may be that the school was designed to meet a lower standard that was in effect at the time the school was

Table 1: Selected ASHRAE Ventilation Recommendations

Type of Area	Occupancy (people/1000 ft²)	CFM/person
Instructional Areas		
Classrooms	50	15
Laboratories	30	20
Music rooms	50	15
Training shops	30	20
Staff Areas		
Conference rooms	50	20
Offices	70	20
Smoking lounges	7	60
Bus garage: 1.5 CFM per square foot of floor area. Distribution among people must consider worker location and concentration of running engines; stands where engines are run must incorporate systems for positive engine exhaust withdrawal. Contaminant sensors may be used to control ventilation.		
Assembly Rooms		
Auditoriums	150	15
Libraries	20	15
Gymnasiums		
spectator areas	150	15
playing floor	30	20
Food and Beverage Service		
Cafeteria	100	20
Kitchen	20	15
Additional airflow may be needed to provide make-up air for hood exhaust(s). The sum of the outdoor air and transfer air of acceptable quality from adjacent spaces shall be sufficient to provide an exhaust rate of not less than 1.5 CFM/square foot.		
Miscellaneous		
Nurse's offices (patient areas)	10	25
Corridors: 0.1 CFM/square foot		
Locker rooms: 0.5 CFM/square foot		
Restroom: 50 CFM/urinal or water closet		

SOURCE: ASHRAE Standard 62-1989, Ventilation for Acceptable Air Quality

built. If you have design specifications for the system or know code requirements in effect at the time of construction, compare the measured outdoor air to this specification. Repair the system to meet the design specification, if necessary

❑ If the school was designed to a lower standard and cannot meet the recommended levels in Table 1, discuss with the IAQ Coordinator means for increasing ventilation:

- Retrofitting the ventilation system for increased capacity
- Opening windows (Caution: Consider potential ventilation problems that this may cause in other parts of the building)

❑ Make any repairs permanent and take any other measures that appear to help ensure adequate outdoor air in the future.

These improvements will probably require the services of a professional engineer.

Deciding Which Equipment to Use for Measuring Airflow

Both flow hoods and pitot tubes can be used to measure airflow. Flow hoods are designed to measure flow at grilles and diffusers. Pitot tubes and anemometers are designed to measure air velocity in ducts, which is then used to calculate airflow. While flow hoods are more expensive to purchase, they are quicker and easier to use. Flow hoods can be used to measure airflow in ducts by summing the airflows from all vents connected to a given duct.

HOW TO MEASURE AIRFLOW

This section provides basic guidance and options for determining air movement and measuring outdoor air supply. It is divided into three sections:

- Using chemical smoke to determine air flow direction
- Measuring airflow to determine outdoor air supply quantity
- Estimating outdoor air quantity using carbon dioxide measurements

1. Using Chemical Smoke to Determine Air Flow Direction

Chemical smoke can be helpful in evaluating HVAC systems, tracking air and pollutant movement, and identifying pressure differentials. Chemical smoke moves from areas of higher pressure to areas of lower pressure if there is an opening between them (e.g., door, utility penetration). Because it is the same temperature as the surrounding air, chemical smoke is extremely sensitive to air currents. Investigators can learn about airflow patterns by observing the direction and speed of smoke movement. Smoke released near outdoor air intakes will indicate whether air is being drawn into the intake. Puffs of smoke released at the shell of the building (by doors, windows, or gaps) will indicate whether the HVAC systems are maintaining interior spaces under positive pressure relative to the outdoors.

Chemical smoke is available with various dispensing mechanisms, including smoke "bottles," "guns," "pencils," or "tubes." The dispensers allow smoke to be released in controlled quantities and directed at specific locations. It is often more informative to use a number of small puffs of smoke as you move along an air pathway rather than releasing a large amount in a single puff.

Caution: *Chemical smoke devices use titanium tetrachloride to produce smoke. While the chemicals forming the smoke normally are not hazardous in the small quantities produced during testing, avoid inhaling smoke from smoke devices. Concentrated fumes from smoke devices are very corrosive.*

Determining Air Movement From Diffusers And Grilles

Puffs of smoke released near HVAC vents give a general idea of airflow. (Is it in or out? Vigorous? Sluggish? No flow?) This is helpful in evaluating the supply and return system and determining whether ventilation air actually reaches the breathing zone. (For a variable air volume system, be sure to take into account how the system is designed to modulate. It could be on during the test, but off for much of the rest of the day.) "Short-circuiting" occurs when air moves directly from supply diffusers to return grilles,

instead of mixing with room air in the breathing zone. If a substantial amount of air short-circuits, occupants may not receive adequate supplies of outdoor air and source emissions may not be diluted sufficiently.

2. Measuring Outdoor Air Supply Quantity

This section describes methods for determining the amount of outdoor air being supplied by a single ventilation unit using either a flowhood or air velocity measurement device. These are general instructions for measuring airflow. Follow the instructions provided by the manufacturer of your measuring equipment.

Step 1. Determine Airflow Quantity

Using a Flow Hood

Flowhoods measure airflow in cubic feet per minute (CFM) at a diffuser or grill. Taking the measurement is simply a matter of holding the hood up to the diffuser and reading the airflow value. Follow the instructions supplied with the flowhood regarding use, care, and calibration.

Using Velocity Measurements

For information on measuring air velocity using a pitot tube or anemometer and calculating outdoor air supply, see the instructions supplied with the equipment

Airflow in large ductwork can be estimated by measuring air velocity using a pitot tube with a differential pressure gauge or an anemometer. (See the IAQ Coordinator for sources of these devices.)

- ❑ Measure the air velocity in the ductwork and calculate the outdoor airflow in cubic feet per minute (CFM) at the outdoor air intake of the air handling unit or other convenient location
- ❑ Enter the calculated outdoor air supply in the Ventilation Log

For Systems Without Mechanically-Supplied Outdoor Air

If your system does not have mechanically supplied outdoor air, you can estimate the amount of outdoor air infiltrating the area. Estimate air infiltrating by measuring the quantity of air exhausted by exhaust fans serving the area

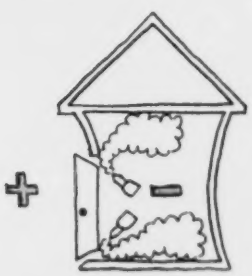
- ❑ Using a small floor plan, such as a fire escape map, mark the areas served by each exhaust fan
- ❑ Measure airflow at grilles or exhaust outlets using a flow hood. Determine the airflow in ductwork by using a pitot tube with a differential pressure gauge or an anemometer
- ❑ Add the airflows (in CFM) from all exhaust fans serving the area you are measuring and enter the measurement in the Ventilation Log

Step 2. Determine Occupancy

Count the number of students and staff located in areas served by the air handling unit (called the occupied

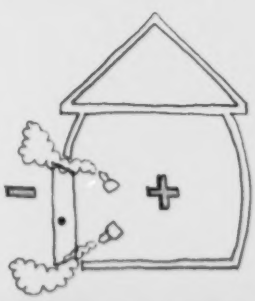
A room can be positively or negatively pressurized when compared to the spaces surrounding it. These spaces include another room, a corridor, or outdoors. To determine whether a room is positively or negatively pressurized, or neutral, release puffs of smoke near the top and bottom of a slightly opened door or window, and observe the direction of flow. Example: If the smoke flows inward at both the top and bottom of a slightly opened door, the room is negatively pressurized when compared to the space on the other side of the door. Negative pressurization may cause problems with natural draft combustion appliances, or cause outdoor pollutants such as pollens or vehicle exhaust in loading docks to be drawn into the building through openings.

Negative Pressure



Neutral Pressure

Positive Pressure



zone). If you are estimating infiltration using exhaust fan airflows, count individuals in the area you have determined are affected by the fan(s) in Step 1.

- ❑ Using a small floor plan, mark the occupied zone served by the unit. In areas served by unit ventilators, an occupied zone is probably an individual classroom. In areas served by large air handling units, an occupied zone may include several rooms. A large gymnasium or other room may be served by several air handling units
- ❑ Estimate the number of occupants in the occupied zone, including students, teachers, other staff members, volunteers and visitors

Step 3. Calculate Outdoor Air Per Person

- ❑ Use the equation below (the equation also appears on the Ventilation Log) to calculate average ventilation rates in CFM/person

3. Estimating Outdoor Air Using Carbon Dioxide Measurements

$$\frac{\text{Outdoor air (CFM)}}{\text{Number of occupants}} = \text{Outdoor air (average CFM/person)}$$

Carbon dioxide (CO_2) is a normal constituent of the atmosphere. Exhaled breath from building occupants and other sources increase indoor CO_2 levels above that of the outdoor air. CO_2 should be measured with a direct-reading meter (See **Appendix B** for sources of CO_2 meters). Use the meter according to manufacturer's instructions. Indoor CO_2 concentrations can, under some test conditions, be used to access outdoor air ventilation. Comparison of peak CO_2 readings between rooms and between air handler zones may help to identify and diagnose various building ventilation deficiencies.

Step 1. Estimate quantity of outdoor air supply.

CO_2 readings, with minimal delays between readings, can be taken at supply outlets or air handlers to estimate the percentage of outdoor air in the supply airstream.

The percentage or quantity of outdoor air is calculated using CO_2 measurements as shown below.

Outdoor air (%) =
(CR-CS)÷(CR-CO) x 100

Where: CS = ppm CO_2 in the supply air (if measured in a room), or in the mixed air (if measured at an air handler)

CR = ppm of CO_2 in the return air

CO = ppm of CO_2 in the outdoor air (Typical range is 300-450 ppm)

All these concentrations must be measured, not assumed.

To convert the outdoor air percent to an amount of outdoor air in cubic feet per minute, use the following calculation:

Outdoor air (CFM) = Outdoor air (percent) ÷ 100 x total airflow (CFM)

The number used for total airflow may be the air quantity supplied to a room or zone, the capacity of an air handler, or the total airflow of the HVAC system. However, the actual amount of airflow in an air handler is often different from the quantity in design documents. Therefore only measured airflow is accurate.

Step 2. Measure CO_2 levels in the area served by a given unit or exhaust fan(s) or in an area without any mechanical ventilation.

The number of occupants, time of day, position of windows and doors, and weather should be noted for each period of CO_2 testing.

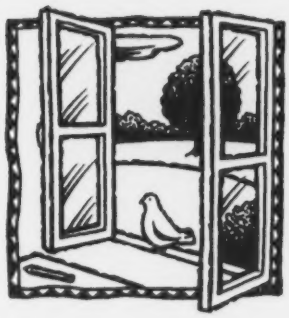
- Measurements taken to evaluate the adequacy of ventilation should be made when concentrations are expected to peak. It may be helpful to compare measurements taken at different times of day. Classroom CO_2 levels will typically rise during the morning, fall during the lunch

period, then rise again, reaching a peak in mid-afternoon. Sample in the mid- to late-afternoon

- Take several CO_2 measurements in the area under consideration. CO_2 measurements for ventilation should be collected away from any source that could directly influence the reading (e.g., hold the sampling device away from exhaled breath)
- Take several measurements outdoors
- For systems with mechanically supplied outdoor air, take one or more readings at the following locations:
  - At the supply air vent
  - In the mixed air (if measured at an air handler)
  - In the return air

Step 3. Note whether CO_2 levels are high.

- Note locations with CO_2 concentrations of 1,000 ppm or higher. Elevated CO_2 indicates that there is not enough outdoor air for the number of people in the space (based on ASHRAE Standard 62, see **Appendix I**)
- Note that there may still be underventilation problems in rooms with peak CO_2 concentrations below 1,000 ppm. CO_2 is produced by human respiration (breathing), and concentrations can change rapidly as people move in and out of a room. Four to six hours of continuous occupancy are often required for CO_2 to approach peak levels



NO PROBLEMS TO REPORT

❑ I have completed the activities on the Ventilation Checklist, and I do not need help in any areas

Ventilation Log

Name _____

Room or Area _____

School _____

Date Completed _____

Signature _____

Instructions:

- ❑ Make one copy of this Log for each ventilation unit in your school.
- ❑ Perform the activities in the Ventilation Checklist for each ventilation unit and use this Log to record results.
- ❑ A "No" response requires further attention.

ACTIVITY	NEEDS ATTENTION IF "NO"	OK (DATE)	ACTIVITY	NEEDS ATTENTION IF "NO"	OK (DATE)
1. Outdoor air intake not obstructed	❑Yes ❑No		15. Economizer set per specifications	❑Yes ❑No	
2. Outdoor air intake clear of nearby pollutant sources	❑Yes ❑No		16. Fans supplying outdoor air operate continuously during occupied periods	❑Yes ❑No	
3. Outdoor air moving into intake	❑Yes ❑No				
4. Filters in good condition, properly installed, and no major air leaks.	❑Yes ❑No		17. Air distribution functioning per design	❑Yes ❑No	
5. Drain pan clean and no standing water	❑Yes ❑No		18. Air flow direction (relative pressures) okay	❑Yes ❑No	
6. Heating and cooling coil(s) clean	❑Yes ❑No		19. Exhaust fan(s) operating	❑Yes ❑No	
7. Interior of air handling unit and ductwork clean	❑Yes ❑No		20. Local exhaust fan(s) remove enough air to eliminate odors and chemical fumes	❑Yes ❑No	
8. Mechanical room free of trash and chemicals	❑Yes ❑No		21. Exhaust ductwork sealed and in good condition	❑Yes ❑No	
9. Controls information on hand	❑Yes ❑No		22. Measure quantity of outdoor air a. outdoor air supply _____ CFM b. number of occupants served by this unit _____ c. CFM/occupants (a÷b) _____ Meets original design specs?	❑Yes ❑No	
10. Clocks, timers, and switches set properly	❑Yes ❑No				
11. Pneumatic controls okay	❑Yes ❑No				
12. Outdoor air damper operating properly	❑Yes ❑No		23. Compare measured CFM/person (c. above) to Table 1		
13. Freeze-stat reset	❑Yes ❑No		• Recommendation in Table 1 for this type of area _____		
14. Mixed air thermostat set properly	❑Yes ❑No		• Meets recommendation?	❑Yes ❑No	

Activity Number	Notes and Comments

Building Maintenance Checklist

This checklist discusses six major topic areas:

- Maintenance Supplies
- Dust Control
- Drain Traps
- Moisture, Leaks, and Spills
- Combustion Appliances
- Pest Control

Instructions:

1. Read the *IAQ Backgrounder*.
2. Check off each box as you complete the activity.
3. Check the triangle(s) as appropriate or check the circle if you need additional help with this activity.
4. Return this checklist to the IAQ Coordinator and keep a copy for future reference.

Name _____

Room or Area _____

School _____

Date Completed _____

Signature _____

MAINTENANCE SUPPLIES

Maintenance supplies may emit air contaminants during use and storage. Products low in emissions are preferable. However, a product that is low in emissions is not necessarily better if it is more hazardous despite the lower emissions, if it has to be used more often, or at a higher strength. Examples of maintenance supplies that may contribute to indoor air quality (IAQ) problems include:

- Caulks
- Solvents
- Paints
- Adhesives
- Sealants
- Cleaning agents

Learn about your maintenance supplies

❑ Review and become familiar with your maintenance supplies

❑ Read labels and identify precautions regarding effects on indoor air or ventilation rates and requirements

Δ Supplies reviewed and okay

○ Need help determining impacts of supplies

If you make purchase decisions, or recommend products for purchase, confirm that supplies are safe to use

❑ Ask vendors and manufacturers to help select the safest products available that can accomplish the job effectively

Δ Supplies are safe to use

○ Need help determining if supplies are safe

Follow good safety, handling, disposal, and storage practices

❑ Develop appropriate procedures and have supplies available for spill control

❑ Exhaust air from chemical and trash storage areas to the outdoors

❑ Store chemical products and supplies in sealable, clearly labeled containers

❑ Follow manufacturers' instructions for use of maintenance supplies

❑ Follow manufacturers' instructions for disposal of chemicals, chemical-containing wastes, and containers

Δ Following good safety, handling, disposal, and storage practices

Δ Safety, handling, storage, and disposal practices are being revised

○ Need help with good safety, handling, disposal, and storage practices

Establish maintenance practices that minimize occupant exposure to hazardous materials

❑ Substitute less- or non-hazardous materials where possible

❑ Schedule work involving odorous or hazardous chemicals for periods when the school is unoccupied

❑ Ventilate during and after use of odorous or hazardous chemicals

Δ Procedures established and followed to minimize occupant exposure

○ Need help to develop and implement procedures to minimize occupant exposure

DUST CONTROL

By reducing the amount of dust and dirt that enters the school, and by reducing the amount of dust that leaves vacuum bags and dust cloths, it will be possible to maintain a clean school with less effort. A cleaner school can also have positive physical and psychological effects on the students and staff. Complaints of illness and discomfort have been associated with buildings having high dust levels. In addition to dust, other particles such as pollens which can cause allergic reactions will also be reduced.

Purchase and maintain barrier floor mats for all school entrances

❑ Barrier mats need to be long enough to allow five full steps for people entering the school (this allows dirt to be cleaned from the mats rather than from all over the school, saving cleaning costs)

❑ Vacuum each barrier mat daily using a beater brush or beater bar vacuum, vacuuming in two directions (in-line and side-to-side)

Δ Barrier mats purchased and maintained

○Need help with barrier mats

Use higher efficiency vacuum bags

❑ Standard paper or cloth bags allow lots of dust to pass completely through the vacuum and back into the air and onto surfaces. Use microfiltration bags which retain dust and particles in the 3 micron size range, or smaller. Although the bags cost more, labor costs are reduced.

Δ High efficiency bags in use

○Need help with obtaining proper bags

Use proper dust wiping techniques

❑ Ensure that dust that has been collected remains on the wipe by using a wiping motion with a folded wipe, rather than a flicking motion with a crumpled-up wipe

❑ Wrap handheld feather-type dusters with a dust cloth. Use a wiping rather than a flicking or sweeping motion

Δ Proper dusting techniques in use

○Need help with dust wiping

Vacuum dust from heating, cooling, and ventilation air return grilles and air supply vents periodically

❑ In addition to vacuuming the grilles and vents using a soft bristle attachment, vacuum the ceiling and wall surfaces adjacent to the grilles and vents to remove visible dust

Δ Dusting is performed periodically

○Need help with dusting grilles and vents

FLOOR CLEANING

All flooring, including vinyl, wood, terrazzo, tile, and carpet, requires daily attention to ensure cleanliness. In addition to the prevention technique of barrier mats as noted in previous activities, apply the following activities. Contact floor suppliers or manufacturers for recommended maintenance techniques. Follow specific guidelines of the Carpet and Rug Institute (CRI) for properly maintaining carpets (to obtain these guidelines, see information in **Appendix I**, ***Resources***).

❑ Vacuum daily as needed for soil removal. Use a vacuum with brushes, beater bars, strong suction, and a high efficiency filter bag that will filter particles down to the 3 micron or smaller range.

❑ Remove spots and stains immediately, using the flooring manufacturer's recommended techniques. Use care to prevent excess moisture or cleaning residue accumulation, and ensure that cleaned areas will dry quickly.

Δ Floors are cleaned daily as needed and moisture has been removed

○Need help with daily floor maintenance

Perform restorative maintenance

❑ Apply the manufacturer's recommended guidelines when cleaning to remove accumulated contaminants. For carpets, CRI recommends periodic extraction cleaning, wet or dry, and complete removal of the moisture and cleaning agents

Δ Restorative maintenance is properly performed as needed

○Need help with restorative floor maintenance

DRAIN TRAPS

Drain traps can cause IAQ problems when water in the drain trap evaporates due to infrequent use. If the building interior is under negative pressure, soil gas or sewer gas can be drawn indoors through a dry drain trap.

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Confirm that all drains have drain traps

❑ Install traps on any untrapped drains

Δ All drains have drain traps

○ Need help with traps

Confirm that all drain traps in areas which only you have access are filled

❑ Pour water down floor drains once per week (about one quart)

❑ Run water in sinks at least once per week (about one pint)

❑ Check water in seldom used toilets once each week. If low, flush

Δ Traps are filled at least once per week

○ Need help filling traps regularly

MOISTURE, LEAKS, AND SPILLS

Many people have allergic reactions to mold and mildew. Mold and mildew can grow almost anywhere that offers a food source and a small amount of moisture, whether from leaks and spills or condensation. Mold and mildew do not require standing water in order to grow. The higher the relative humidity, the higher the probability of fungal growth.

Assemble the following tools before starting the activities:

- a small floorplan for taking notes
- an instrument to measure relative humidity (e.g., sling psychrometer)

Inspect the building for signs of moisture, leaks, or spills

❑ Check for moldy odors

❑ Look for stains or discoloration on the ceiling, walls, or floor

❑ Check cold surfaces (e.g., locations under windows and in corners formed by exterior walls, uninsulated cold water piping)

❑ Check areas where moisture is generated (e.g., locker rooms, bathrooms)

❑ Look for signs of water damage in:

- indoor areas in the vicinity of known roof or wall leaks
- walls around leaky or broken windows
- floors and ceilings under plumbing
- duct interiors near humidifiers, cooling coils, and outdoor air intakes

❑ If you discover active leaks during your inspection, note their location(s) on your floor plan and repair them as quickly as possible

Δ There are no signs of moisture, leaks, or spills

○ Found signs of moisture, leaks, or spills, or need help inspecting

Respond promptly when you see signs of moisture, or when leaks or spills occur

❑ Clean and dry damp or wet building materials and furnishings

❑ Work with manufacturers of furnishings and building materials to learn recommended cleaning procedures and/or identify competent contractors who can clean damp materials

❑ Porous, absorbent building materials or furnishings, such as ceiling tiles, wall boards, floor coverings, etc., must be thoroughly dried and cleaned as soon as possible. In some cases these materials might have to be disinfected. If these materials can't be dried and cleaned within 24 hours, they may have to be replaced after the cause of the moisture problem has been corrected

Δ Moisture, leaks, or spills fixed

○ Need help fixing damage from moisture, leaks, or spills

Prevent moisture condensation

There are several methods to prevent condensation:

❑ Reduce the potential for condensation on cold surfaces (piping, exterior walls, roof, or floor) by adding insulation. (*Note:* When installing insulation that has a vapor barrier, put the vapor barrier on the warm side of the insulation.)

❑ Raise the temperature of the air

BEST COPY AVAILABLE

❑ Improve air circulation in the problem location

❑ Decrease the amount of water vapor in the air

- In dryer climates or winter, supply more outdoor ventilation air
- In humid climates or during humid times of the year, use a dehumidifier or desiccants to dry the air (for more information, obtain **Appendix H** from the IAQ Coordinator)
- Increase the capacity or operating schedule of existing exhaust fan(s); or add a local exhaust fan near the source of the water vapor

Δ Moisture prevention activities completed

Δ Moisture prevention activities underway

○ Need help with moisture prevention activities

COMBUSTION APPLIANCES

Combustion appliances are potential sources of carbon monoxide and other combustion gases. Carbon monoxide is odorless yet toxic, so it is important that appliances are properly vented to remove combustion gases. If inadequate combustion air is available to an appliance, air may be pulled, or backdrafted, down the flue, bringing combustion gases back into the indoors instead of exhausting them outside.

Note odors when first entering a location containing combustion appliances

❑ One's nose quickly becomes accustomed to odors, but upon first entering a room the smell of combustion gas odors may indicate a leak or backdrafting problem

Δ No combustion odors

○ Need help resolving combustion gas problem

Visually inspect exhaust components

❑ Inspect flue components for leaks, disconnections, and deterioration

❑ Inspect flue components for corrosion and soot

Δ No apparent problems

○ Need help repairing exhaust components

Check for backdrafting of combustion appliances

❑ When the combustion appliance(s) is operating, and the building ventilation systems are in normal operating mode, use chemical smoke to determine whether air is flowing up the flue by puffing smoke near any vent openings or joints

Δ No backdrafting

○ Need help resolving backdrafting problem

PEST CONTROL

Use Integrated Pest Management (IPM) methods of pest control

❑ Do not rely on widespread, indiscriminate use of pesticides to control pests

❑ If you are in charge of pest control, obtain information about IPM from the IAQ Coordinator

❑ If pesticides are used outdoors, do not apply near outdoor air intakes for the ventilation system. If unavoidable, shut down the affected ventilation system(s) and remove occupants until application has been completed and ventilation has been restored. Similarly, avoid application near doors and open windows

Δ No pest problems

Δ Already using Integrated Pest Management

○ Need information or assistance with IPM

NO PROBLEMS TO REPORT

❑ I have completed all activities on this Checklist, and I do not need help in any areas

Food Service Checklist

This checklist discusses four major topic areas:

- Cooking Area
- Food Handling and Storage
- Waste Management
- Receiving

These activities also apply to home-economics instructional areas.

Instructions:

1. Read the *IAQ Backgrounder.*
2. Check off each box as you complete the activity.
3. Check the triangle as appropriate or check the circle if you need additional help with this activity.
4. Return this checklist to the IAQ Coordinator and keep a copy for future reference.

Name _____

School _____

Date Completed _____

Signature _____

COOKING AREA

Cooking activities generate odors, moisture, food waste, and other trash, all of which must be managed carefully to avoid indoor air quality (IAQ) problems. Food odors can be a distraction to students and staff if they circulate through the school.

Confirm that local exhaust fans function properly

❑ Check for air flow when fans are on. (Hold a piece of tissue paper near the fan to see whether it is pulled toward the fan)

❑ Check for cooking odors or smoke in areas adjacent to the cooking, preparation, and eating areas

❑ Make sure fan is not excessively noisy (excessive noise may indicate a problem or may cause the fan to not be used)

Δ Fans function; no odors or smoke in adjacent areas

○ Need help, local exhaust fan does not appear to function properly

Use exhaust fans whenever cooking, dishwashing, and cleaning.

❑ Make sure staff understand the importance of using the fans to prevent moisture accumulation and the spread of food odors

❑ Train staff to use fans when cooking, dishwashing, or cleaning

❑ Monitor use of fans from time to time throughout the year

Δ Fans are used as appropriate

○ Need help to confirm whether fans are used appropriately

Confirm gas appliances function properly

❑ Verify that gas appliances are vented outdoors

❑ Check for combustion gas odors, headaches when gas appliances are in use, or natural gas odors at any time

❑ All gas appliances vented as appropriate

Δ No leaks or exhaust odors

○ Need help checking for (or have detected problems with) leaks, odors, backdrafting, venting to outdoors

Clean kitchen after use

❑ Inspect kitchen for signs of microbiological growth (check for moldy odors, slime, algae)

❑ Check hard-to-reach places such as the upper walls and ceiling for evidence of mold growth

❑ Clean affected areas as needed

❑ If biocides are used, select only products registered by EPA for such use, follow the manufacturer's directions for use, and pay careful attention to the method of application

Δ No signs of microbiological growth

○ Need help checking for mold or cleaning

Inspect kitchen for plumbing leaks

❑ Check sink faucets and area under sinks

❑ Look for stains or discoloration, and/or damp or wet areas

Δ No plumbing leaks

○ Found leaks, need help to fix leaks

FOOD HANDLING AND STORAGE

A clean kitchen with food stored in secure containers discourages vermin. Integrated Pest Management (IPM) practices minimize the need for pesticides and discourage pests by eliminating the food sources, pathways, and shelter they need. The IAQ Coordinator can help you and your staff learn more about IPM.

Check food preparation, cooking, and storage areas regularly for signs of insects and vermin

❑ Look for dead insects or rodents

❑ Look for feces

❑ Notify IAQ Coordinator if insects or vermin infestation is discovered

Δ No signs of insects or vermin

○ Need help, found signs of insects or vermin

Confirm that appropriate food preparation, cooking, and storage practices are implemented

❑ Review food handling and storage practices — containers should be well-sealed, with no traces of food left on outside surfaces of containers

Maintain general cleanliness

❑ Dispose of food scraps properly and remove crumbs

❑ Wipe counters clean with soap and water or a disinfectant, according to school policy

❑ Sweep and wet mop floors to remove food

❑ Clean stoves and ovens after use

Δ Food service area is clean

○ Need help cleaning food service area

WASTE MANAGEMENT

Food wastes and food-contaminated paper products produce odors and encourage insects and vermin. Proper placement of dumpsters prevents odors from entering the building and minimizes opportunities for insects and vermin to enter the building.

Place waste in appropriate containers

❑ Containers should have lids that close securely

❑ If possible, separate food waste and food-contaminated items from other wastes

Δ Waste is stored in appropriate containers

○ Need appropriate containers

Locate dumpsters well away from air intake vents, operable windows, and food service doors

Δ Dumpster(s) properly located

○ Need help determining proper dumpster placement, or moving dumpster(s)

RECEIVING

The kitchen is often the busiest part of the school for deliveries. Because fans are exhausting air from the kitchen (i.e., the kitchen is negatively pressurized), air from an adjacent loading dock may be drawn into the kitchen. If delivery trucks or other vehicles idle at the dock, exhaust fumes can be drawn in and cause problems.

Remind vendors not to idle their engines

❑ Post a sign prohibiting vehicles from idling their engines in receiving area

❑ Ask drivers to turn off their engines if they don't follow instructions on the sign

Δ Vendors turn off engines in receiving area

○ Need help, vendors do not turn off engines

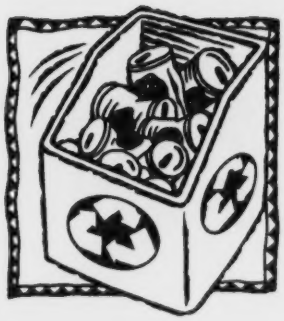
Keep doors or air barriers closed between receiving area and kitchen

❑ Door(s) regularly closed

○ Need help keeping door(s) closed

NO PROBLEMS TO REPORT

❑ I have completed all activities on this Checklist, and I do not need help in any areas



Waste Management Checklist

Instructions:

1. Read the *IAQ Backgrounder.*
2. Check off each box as you complete the activity.
3. Check the triangle as appropriate or check the circle if you need additional help with this activity.
4. Return this checklist to the IAQ Coordinator and keep a copy for future reference.

WASTE MANAGEMENT

Proper waste management promotes good indoor air quality (IAQ) by controlling odors and contaminants, and is a pest management method which controls vermin. Good sanitation decreases the need for pesticides.

Select waste containers by considering the kind of waste that is placed in them

❑ Food waste or food-contaminated papers and plastics should be contained securely (e.g., covered containers, tied-off plastic bags) to discourage flies and other vermin

❑ Recycling bins should be clearly labeled so people don't put other types of trash in them

❑ Some materials may require special handling; for example, waste generated in art classes, science classes, and vocational/industrial education classes. Work with teachers or administrator to identify the best methods for handling special wastes

Δ Existing waste containers are appropriate and do not need to be changed

Δ New waste containers appropriate to their waste are being installed

○ Need help to select and obtain appropriate waste containers

Locate dumpsters away from outdoor air intakes, doors, and operable windows

❑ Ideally, prevailing winds should carry odors and contaminants away from the building

❑ Dumpsters are located away from air intakes, doors, and operable windows

Δ Dumpsters are being moved

○ Need help to find appropriate location and/or move dumpsters

Empty waste containers regularly and frequently, and store them in an appropriate location

❑ Follow a regular schedule that minimizes odors and deprives vermin of their food source

❑ Containers that have plastic liners regularly replaced do not need to be cleaned and disinfected as often as unlined containers

❑ Do not store waste containers in rooms which have heating, cooling, or ventilation equipment that supplies conditioned air to other rooms

Δ Waste containers are emptied regularly and frequently

Δ Waste containers are stored in an appropriate location

○ Need help to modify waste removal schedule

NO PROBLEMS TO REPORT

❑ I have completed the activities on the Waste Management Checklist, and I do not need help in any areas

Name

School

Date Completed

Signature

Renovation and Repair Checklist

This checklist discusses four major topic areas:

- General Activities
- Painting
- Flooring
- Roofing

Instructions:

1. Read the *IAQ Backgrounder.*
2. Check off each box as you complete the activity.
3. Check the triangle as appropriate or check the circle if you need additional help with this activity.
4. Return this checklist to the IAQ Coordinator and keep a copy for future reference.

Name

Dept. or Company

School

Date Completed

Signature

When planning and conducting renovations in schools, it is important to remember four potential causes of indoor air problems during renovation and repairs:

- Demolition that releases toxic materials
- Construction dust and fumes
- Designs that interfere with ventilation
- Off-gassing from building materials and new products

You can minimize these problems by making good indoor air quality (IAQ) one of the criteria during project planning. Also, contract language and negotiations with the service providers (contractors) can help ensure that proper materials and procedures are used, such as performing work during unoccupied periods. This Checklist is for use before and during renovation projects.

Depending on who is performing the work, you may need to give sections of this Checklist covering one or more of the activity groups to separate in-house staff or contractors. Instruct those who receive a portion of the Checklist to return it to the IAQ Coordinator.

See **Appendix I, *Resources***, for additional sources of information on the following activities.

GENERAL ACTIVITIES

❑ Do not disturb asbestos during demolition. Most schools have identified and dealt with asbestos in the school under state or Federal requirements. Schools that have asbestos-containing materials, as identified in an AHERA survey, should have a management plan on file at the school. Refer to the management plan when considering whether planned renovations will require disturbing areas containing asbestos. Use an asbestos professional to consult on and assist with such renovation work. Be sure to update the AHERA management plan to reflect any asbestos abatement activities

❑ Test for lead-based paint before removing old paint. Use a certified inspector (if your state certifies inspectors) or a reputable testing firm for areas to be demolished, sanded, or stripped. Use appropriate personnel and precautions when removing and disposing of lead-based paint

❑ Avoid exposure to fungi and bacteria. If renovation is likely to expose large areas of microbial growth such as mold and mildew (for example, while repairing water damage), consult with an environmental professional about adequate protective measures to ensure both worker and occupant safety

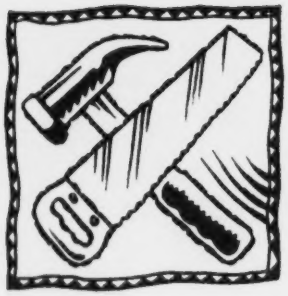
❑ Plan to isolate students and staff from any dust or fumes generated during renovation work. Use plastic sheeting, portable fans, and a mechanical ventilation strategy (where applicable) to prevent dust and fumes from reaching school occupants through hallways, doors, windows, and the ventilation system (for additional details, see the activity groups). Also consider conducting renovation work during hours when the school is unoccupied

❑ Consider the effect of the renovation on ventilation and mixing of air in rooms. Beware of cutting off a room from its supply of outdoor air, enclosing a pollutant source (like photocopiers) in a room with inade-

quate exhaust or supply air, or erecting barriers that prevent adequate movement of air throughout the occupied area of a room

❑ Minimize and provide for off-gassing from new products. New products contain volatile constituents, such as resins, solvents, and binders, which off-gas volatile organic compounds for a period of time. This process is called "off-gassing." Whenever possible, obtain information on emissions from potential new products to be installed in the school and select lower emitting products when available. Whenever new products with the potential for off-gassing are installed, allow adequate time for off-gassing before reoccupying the area and increase ventilation with outdoor air until off-gassing odors and any irritation symptoms no longer occur. Examples of products which will potentially off-gas include:

- Wall paneling
- Draperies
- Composite wood furniture and cabinets
- Cubicle dividers
- Carpet and vinyl flooring
- Paints and finishes



Instructions:

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4. Return this checklist to the IAQ Coordinator and keep a copy for future reference.

Name

Dept. or Company

School

Date Completed

Signature

PAINTING

There are many factors to consider before beginning a painting project. Special care should be taken when sanding a surface to prepare for painting, due to the dust released into the air. The dust may contain lead particles. Exposure to excessive levels of lead could affect a child's mental growth, and interfere with nervous system development, which could cause learning disabilities and impaired hearing. In adults, lead can increase blood pressure.

The type of paint is an important decision. For instance, both solvent-based and water-based paints give off volatile organic compounds (VOCs) that could lead to IAQ problems. Water-based paints produce less VOCs than solvent-based paints, but produce them over a longer period of time.

Durability is important — a relatively low-emitting paint might create more IAQ problems in the long run than a higher-emitting paint, if the low-emitting paint requires repainting more often. In addition, many water-based paints (even interior paints) have, until recently, used mercury as a fungicide. Any paint that contains mercury should not be used indoors.

Confirm that the painted surface is lead-free before preparing a surface for repainting

❑ Check painting records or old paint cans to determine whether the paint contains lead

❑ Do an initial screen using a trained lead paint inspector

❑ If there is lead in the existing paint, contact a trained lead-based paint contractor

Δ No lead in existing paint

○ Paint contains lead or testing is needed to determine if lead is in existing paint

Select a low-VOC emitting paint that is free of lead and mercury

❑ Evaluate existing stock of paint (properly dispose of paints containing lead or mercury or having higher VOC emissions than new paints)

❑ Evaluate new paint before you purchase it. Express your indoor air quality concerns to paint suppliers and use their technical personnel as a resource. Not all paint suppliers have information on pollutant emissions; consult other sources (e.g., manufacturers) if your paint supplier cannot provide adequate information

Δ Have selected an appropriate paint

○ Need to discuss which paint to use with an IAQ specialist

During exterior painting, minimize occupant exposure to odors and contaminants

❑ Schedule exterior painting to occur when the building is unoccupied (for example; weekends or vacation periods)

❑ Keep nearby windows and doors closed as much as possible

Δ Occupant exposure is minimized

○ Need help to minimize occupant exposure

During interior painting, minimize occupant exposure to odors and pollutants

❑ Schedule painting to occur when the area is unoccupied (for example, on weekends or during vacation periods), and allow time for paint odors to dissipate before occupants return to the area. If the area being painted

has a heating, cooling, and ventilation system which is shared with other areas, those areas should also be unoccupied.

❑ Use supply and exhaust fans to sweep paint fumes out of the building. Operate supply fans continuously (24 hours/day, 7 days/week), at the highest possible outdoor air supply setting, from the beginning of the painting work until several days after painting has been completed

❑ Block return openings to prevent circulating air from the work area to occupied areas

Δ **Occupant exposure is minimized**

○ **Need help to minimize occupant exposure**

Use appropriate storage and disposal practices for paints, solvents, clean-up materials, and asbestos containing materials

❑ Seal containers carefully after use

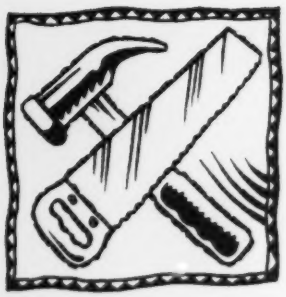
❑ Keep paint containers in designated storage areas equipped with exhaust ventilation, but not in heating, ventilation, and air conditioning equipment rooms

❑ Use an appropriate waste disposal method to dispose of any paints containing lead or mercury

❑ Follow EPA National Emission Standards for Hazardous Air Pollutant rules for disposal of asbestos-containing materials

Δ **No problem with storage and disposal**

○ **Need help with storage and disposal**



Instructions:

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Name

Dept. or Company

School

Date Completed

Signature

FLOORING

As is the case with other building materials and furnishings, flooring materials have the potential to impact indoor air quality, therefore selection of flooring materials is an important consideration during the renovation process. Potential pollutants from flooring materials which can impact IAQ include volatile organic compounds (VOCs) that off-gas directly from many flooring materials and the cleaning products used to maintain the flooring. Dirty and persistently damp flooring materials can become a location for the growth of biological contaminants, such as fungi. Proper cleaning and maintenance of flooring materials helps to improve IAQ.

When your school installs flooring materials, the following selection, repair, and installation activities will help protect the indoor air quality in the school.

Determine whether resilient tile flooring scheduled for removal contains asbestos fibers

❑ Asbestos surveys conducted under AHERA may have identified asbestos-containing floor tiles. Refer to the inspection report and management plan on file at the school

❑ Follow notification and handling procedures defined under the National Emission Standards for Hazardous Air Pollutants (NESHAP, 40 CFR Part 61 Subpart M) if renovations will disturb asbestos-containing tile flooring

Δ No asbestos-containing flooring will be disturbed

○ Renovation may/will disturb asbestos-containing flooring

Select low-emitting adhesive when installing glue-down flooring

❑ Use low-emitting adhesives

❑ Follow manufacturer's recommendations for ventilating the work area

Δ Selected a low-emitting adhesive

○ Need additional information for selecting low-emitting adhesive

Select low-emitting flooring materials

❑ Ask manufacturers to submit information about product constituents and emissions that may adversely impact IAQ

❑ The Carpet and Rug Institute (CRI) has a carpet testing and labeling program. If your carpet supplier cannot provide information on any carpets you are considering, contact CRI (800-882-8846) to obtain data on emissions from these carpets

Δ Selected a low-emitting flooring system

○ Need additional information for selecting a low-emitting flooring system

Air out new products before installation

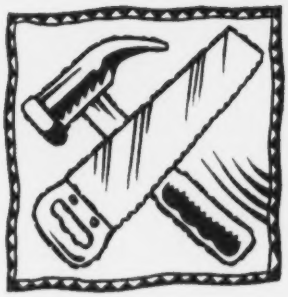
❑ If practical, unwrap and unroll flooring products and cushion (if any) in a well-ventilated location prior to installation, preferably in a location other than the school, such as a ventilated warehouse

Δ Flooring products will be aired out before installation

○ Need help arranging air out of flooring products

Air out the space during and after flooring installation

❑ Install carpet, vinyl, and related flooring materials only when the school building is not in use, except in the case of a small installation



where you are able to exhaust the air from the space directly to the outdoors and maintain the room under negative pressure relative to the surrounding rooms and hallways

❑ The typical recommendation is to continuously operate the building ventilation system at normal temperature and maximum outdoor air during installation and for at least 72 hours after installation is completed. The Carpet and Rug Institute Standard for Installation of Commercial Textile Floorcovering Materials (CRI 104) addresses airing and other installation procedures for carpet

❑ Avoid recirculating air from the installation area, through the heating, ventilation, and air conditioning system, and into occupied areas. Seal return air grilles, open doorways, stairways, and use exhaust fans to remove airborne contaminants

Δ **Space will be aired out as prescribed**

○ **Need help arranging air out of space during and after installation**

Require the installer to clean flooring with a high efficiency particulate air (HEPA) filtration vacuum

❑ Vacuum old carpet that is to be removed and subfloor surfaces (once carpet is removed) to reduce release of particles such as dirt, dust, and biologicals into the air and onto the new carpet

❑ Vacuum new flooring after installation to remove loose matter and particles generated by the installation process and general construction in the area

Δ **Surfaces vacuumed before removal and/or after installation**

○ **Need help with HEPA vacuuming**

Do not install carpet near water sources

❑ In areas where there is a perpetual moisture problem, do not install carpet, i.e., by drinking fountains, classroom sinks, or concrete floors with leaks or frequent condensation

❑ To reduce the potential for microbial growth in the joints of hard surfaces or porous flooring installed near water sources, be sure to seal entire surface

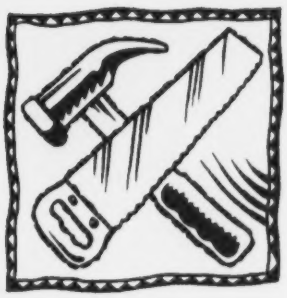
Δ **No carpet will be installed near water sources**

Δ **Hard surface flooring installed near water sources sealed**

○ **Carpet installation planned near water sources or porous hard surface flooring unsealed**

NO PROBLEMS TO REPORT

❑ I have completed the activities on the Renovation and Repair Checklist, and I do not need help in any areas



ROOFING

Roofing work often involves the use of tar or other pollutant-producing chemicals which may cause indoor air problems if fumes enter the building. School officials and roofers can cooperate to prevent these problems and complaints from occupants.

Schedule pollutant-producing activities for unoccupied periods (e.g., weekends or vacation periods)

❑ Check to ensure that pollutant-producing activities occur during unoccupied periods

Δ Work is scheduled for an unoccupied period

○ Work is scheduled for an occupied period; need help to minimize occupant exposure

Locate "hot pots" of tar and other pollutant-producing materials away from outdoor air intakes

❑ Consider wind patterns at the work site, and arrange equipment so prevailing winds carry odors away from the building

Δ Pollutant-producing materials are away from and downwind of outdoor air intakes

○ No good location for pollutant-producing materials

Modify ventilation to avoid introducing odors and contaminants

❑ Advise staff and students to keep doors and windows closed until the roofing work is finished

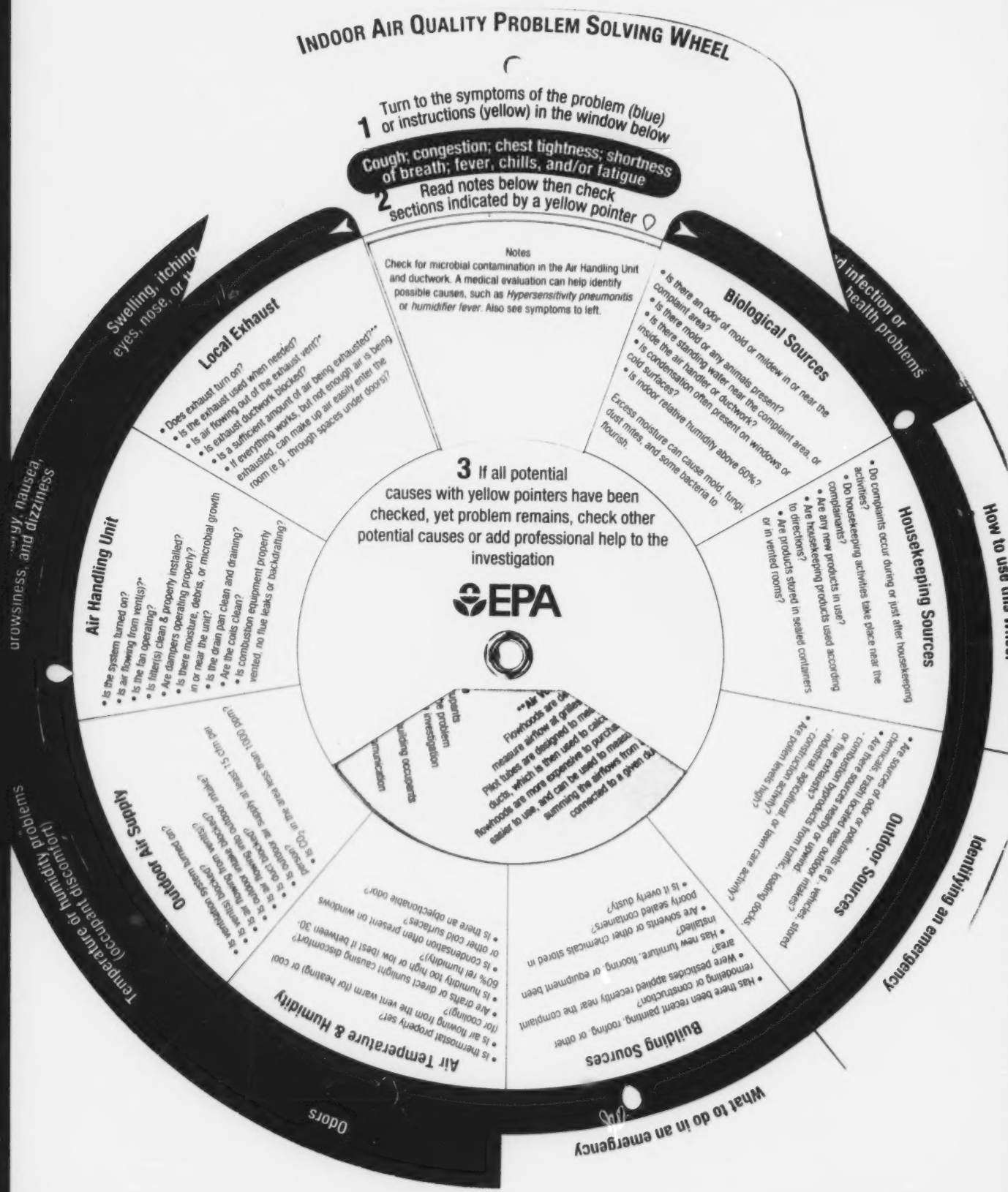
❑ It may be advisable to temporarily close the outdoor air intakes of air handlers; particularly rooftop units in the vicinity of (and downwind from) the work area. (NOTE: To avoid creating IAQ problems from underventilation, provide a temporary means (fans and/or ducts) to supply unaffected outdoor air.)

Δ Ventilation is arranged to avoid entry of pollutants

○ Need help to modify ventilation

Instructions:

1. Read the *IAQ Backgrounder.*
2. Check off each box as you complete the activity.
3. Check the triangle as appropriate or check the circle if you need additional help with this activity.
4. Return this checklist to the IAQ Coordinator and keep a copy for future reference.


INDOOR AIR QUALITY PROBLEM SOLVING WHEEL
1 Turn to the symptoms of the problem (blue) or instructions (yellow) in the window below
Cough; congestion; chest tightness; shortness of breath; fever, chills, and/or fatigue
2 Read notes below then check sections indicated by a yellow pointer
Notes
Check for microbial contamination in the Air Handling Unit and ductwork. A medical evaluation can help identify possible causes, such as Hypersensitivity pneumonitis or humidifier fever. Also see symptoms to left.
Biological Sources
• Is there an odor of mold or mildew in or near the complaint area?
• Is there mold or any animals present?
• Is there standing water near the complaint area, or inside the air handler or ductwork?
• Is condensation often present on windows or cold surfaces?
• Is indoor relative humidity above 60%?
Excess moisture can cause mold, fungi, dust mites, and some bacteria to flourish.
Housekeeping Sources
• Do complaints occur during or just after housekeeping activities?
• Do housekeeping activities take place near the complainants?
• Are any new products in use?
• Are housekeeping products used according to directions?
• Are products stored in sealed containers or in vented rooms?
Outdoor Sources
• Are sources of odor or pollutants (e.g., vehicles, stored chemicals, trash) located near outdoor intakes?
• Are there sources nearby or upwind (combustion byproducts from traffic, loading docks, industrial processes, agricultural or farm activity)?
• Are pollen levels high?
Building Sources
• Has there been recent painting, roofing, or other remodeling or construction?
• Were pesticides applied recently near the complaint area?
• Has new furniture, flooring, or equipment been installed?
• Are solvents or other chemicals stored in poorly sealed containers?
• Is it overly dusty?
Air Temperature & Humidity
• Is thermostat properly set?
• Is air flowing from the vent warm (or cool (or cooling)?
• Are drafts or direct sunlight causing discomfort?
• Is humidity too high or low (best if between 30-60% rel humidity)?
• Is condensation often present on windows or other cold surfaces?
• Is there an objectionable odor?
Outdoor Air Supply
• Is ventilation system turned on?
• Is the outdoor intake damaged?
• Is outdoor intake screened?
• Is the outdoor air supply at least 15 cfm per person?
• Is CO2 in the area less than 1000 ppm?
Air Handling Unit
• Is the system turned on?
• Is air flowing from vent(s)?
• Is the fan operating?
• Is filter(s) clean & properly installed?
• Are dampers operating properly?
• Is there moisture, debris, or microbial growth in or near the unit?
• Is the drain pan clean and draining?
• Are the coils clean?
• Is combustion equipment properly vented, no flue leaks or backdrafting?
Local Exhaust
• Does exhaust turn on?
• Is the exhaust used when needed?
• Is air flowing out of the exhaust vent?*
• Is exhaust ductwork blocked?
• Is a sufficient amount of air being exhausted?**
• If everything works, but not enough air is being exhausted, can make up air easily enter the room (e.g., through spaces under doors)?
3 If all potential causes with yellow pointers have been checked, yet problem remains, check other potential causes or add professional help to the investigation
EPA
Swelling, itching eyes, nose, or
drowsiness, and dizziness
Temperature or humidity problems (occupant discomfort)
Odors
What to do in an emergency
Identifying an emergency
How to use this Wheel
infection or health problems

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Indoor Air Quality

Problem Solving Wheel

Spatial Patterns of Complaints

Widespread, no apparent spatial pattern	• Check ventilation and temperature control for entire building • Check outdoor air quality • Review sources that are spread throughout the building (e.g., cleaning materials or microbiological growth inside the ventilation system) • Check for distribution of a source to multiple locations through the ventilation system • Consider explanations other than air contaminants
Localized (e.g., affecting individual rooms, zones, or air handling systems)	• Check ventilation and temperature control within the complaint area • Review pollutant sources affecting the complaint area • Check local HVAC system components that may be acting as sources or distributors of pollutants
Individual(s)	• Check for drafts, radiant heat (gain or loss), and other localized temperature control or ventilation problems near the affected individual(s) • Consider that common background sources may affect only susceptible individuals • Consider the possibility that individual complaints may have different causes that are not necessarily related to the building (particularly if the symptoms differ among the individuals)

Important . . .

This Wheel provides an easy, step-by-step process for identifying and solving common indoor air quality problems. It is important that this Wheel be used in conjunction with more detailed guidance, as provided in either of the publications noted below, which can be purchased from the US Government Printing Office by calling 202-512-1800.

Indoor Air Quality Tools for Schools Kit
S/N 055-000-00503-6

Building Air Quality: A Guide for Building Owners and Facility Managers
S/N 055-000-00390-4

The tables to the left and right can be helpful in defining the complaint area, and in determining patterns in the timing of symptoms. The complaint area may need to be revised as the investigation continues. Keep in mind that symptoms may result from a combination of minor problems. Using this Wheel will not necessarily identify or solve all problems caused by indoor air pollution.

Timing Patterns of Complaints

Symptoms begin and/or are worst at the start of the occupied period	• Review HVAC operating cycles. Pollutants from building materials, or from the HVAC system itself, may build up during unoccupied periods.
Symptoms worsen over course of occupied period	• Consider that ventilation may not be adequate to handle routine activities or equipment operation within the building, or that temperature is not properly controlled.
Intermittent Symptoms	• Look for daily, weekly, or seasonal cycles or weather-related patterns, and check linkage to other events in and around the school.
Single event of symptoms	• Consider spills, other unrepeated events as sources.
Recent onset of symptoms	• Ask staff and occupants to describe recent changes or events (e.g., remodeling, renovation, redecorating, HVAC system adjustments, leaks, or spills).
Symptoms relieved on leaving the school, either immediately, overnight, or (in some cases) after extended periods away from the building	• Consider that the problems may be building-associated, though not necessarily due to air quality. Other stressors (e.g., lighting, noise) may be involved.
Symptoms never relieved, even after extended absence from school (e.g., vacations)	• Consider that the problem may not be building-related.

For more information on other IAQ topics and publications, contact IAQ INFO
800-438-4318 or 202-484-1307

EPA

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INDOOR AIR POLLUTION

An Introduction for Health Professionals

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Introduction

Indoor air pollution poses many challenges to the health professional. This booklet offers an overview of those challenges, focusing on acute conditions, with patterns that point to particular agents and suggestions for appropriate remedial action.

The individual presenting with environmentally associated symptoms is apt to have been exposed to airborne substances originating not outdoors, but indoors. Studies from the United States and Europe show that persons in industrialized nations spend more than 90 percent of their time indoors[1]. For infants, the elderly, persons with chronic diseases, and most urban residents of any age, the proportion is probably higher. In addition, the concentrations of many pollutants indoors exceed those outdoors. The locations of highest concern are those involving prolonged, continuing exposure—that is, the home, school, and workplace.

The lung is the most common site of injury by airborne pollutants. Acute effects, however, may also include non-respiratory signs and symptoms, which may depend upon toxicological characteristics of the substances and host-related factors.

Heavy industry-related occupational hazards are generally regulated and likely to be dealt with by an on-site or company physician or other health personnel[2]. This booklet addresses the indoor air pollution problems that may be caused by contaminants encountered in the daily lives of persons in their homes and offices. These are the problems more likely to be encountered by the primary health care provider.

Etiology can be difficult to establish because many signs and symptoms are nonspecific, making differential diagnosis a distinct challenge. Indeed, multiple pollutants may be involved. The challenge is further compounded by the similar manifestations of many of the pollutants and by the similarity of those effects, in turn, to those that may be associated with allergies, influenza, and the common cold. Many effects may also be associated, independently or in combination with, stress, work pressures, and seasonal discomforts.

Because a few prominent aspects of indoor air pollution, notably environmental tobacco smoke (p. 5) and "sick building syndrome" (p. 17), have been brought to public attention, individuals may volunteer suggestions of a connection between respiratory or other symptoms and conditions in the home or, especially, the workplace. Such suggestions should be seriously considered and pursued, with the caution that such attention could also lead to inaccurate attribution of effects. Questions listed in the diagnostic leads sections will help determine the cause of the health problem. The probability of an etiological association increases if the individual can convincingly relate the disappearance or lessening of symptoms to being away from the home or workplace.

How To Use This Booklet

The health professional should use this booklet as a tool in diagnosing an individual's signs and symptoms that could be related to an indoor air pollution problem. The document is organized according to pollutant or pollutant group. Key signs and symptoms from exposure to the pollutant(s) are listed, with diagnostic leads to help determine the cause of the health problem. A quick reference summary of this information is included in this booklet (pg.3). Remedial action is suggested, with comment providing more detailed information in each section. References for information included in each section are listed at the end of that section.

It must be noted that some of the signs and symptoms noted in the text may occur only in association with significant exposures, and that effects of lower exposures may be milder and more vague, unfortunately underscoring the diagnostic challenge. Further, signs and symptoms in infants and children may be atypical (some such departures have been specifically noted).

The reader is cautioned that this is not an all-inclusive reference, but a necessarily selective survey intended to suggest the scope of the problem. A detailed medical history is essential, and the diagnostic checklist (pg.4) may be helpful in this regard. Resolving the problem may sometimes require a multidisciplinary approach, enlisting the advice and assistance of others outside the medical profession. The references cited in the notes throughout and in the *For Assistance and Additional Information* section will provide the reader with additional information.

References

[1] U.S. Environmental Protection Agency, Office of Air and Radiation. Report to Congress on Indoor Air Quality, Volume II: Assessment and Control of Indoor Air Pollution, pp. 1, 4-14. EPA-400-1-89-001C, 1989.

[2] The U.S. Environmental Protection Agency sets and enforces air quality standards only for ambient air. The Toxic Substances Control Act (TSCA) grants EPA broad authority to control chemical substances and mixtures that present an unreasonable risk of injury to health and environment. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) authorizes EPA to control pesticide exposures by requiring that any pesticide be registered with EPA before it may be sold, distributed, or used in this country. The Safe Drinking Water Act authorizes EPA to set and enforce standards for contaminants in

public water systems. EPA has set several standards for volatile organic compounds that can enter the air through volatilization from water used in a residence or other building. As to the indoor air in workplaces, two Federal agencies have defined roles concerning exposure to (usually single) substances. The National Institute for Occupational Safety and Health and Human Services (NIOSH), part of the Department of Health and Human Services, reviews scientific information, suggests exposure limitations, and recommends measures to protect workers' health. The Occupational Safety and Health Administration (OSHA), part of the Department of Labor, sets and enforces workplace standards. The U.S. Consumer Product Safety Commission (CPSC) regulates consumer products which may release indoor air pollutants. In the United States there are no Federal Standards that have been developed specifically for indoor air contaminants in non-occupational environments. There are, however, some source emission standards that specify maximum rates at which contaminants can be released from a source.

For more extensive information, see the publication cited above, in particular Chapter 7, "Existing Indoor Air Quality Standards", and Chapter 9, "Indoor Air Pollution Control Programs".

Diagnostic Quick Reference

Signs and Symptoms	Environmental Tobacco Smoke	Other Combustion Products	Biological Pollutants	Volatile Organics	Heavy Metals	Sick Bldg Syndrome
	pp.5	pp.7	pp.10	pp.13	pp.15	pp.17
Respiratory						
Rhinitis, nasal congestion	■	■	■	■		■
Epistaxis				■[1]		
Pharyngitis, cough	■	■	■	■		■
Wheezing, worsening asthma	■	■		■		■
Dyspnea	■[2]		■			■
Severe lung disease						■[3]
Other						
Conjunctival irritation	■	■	■	■		■
Headache or dizziness	■	■	■	■	■	■
Lethargy,fatigue, malaise		■[4]	■[5]	■	■	■
Nausea, vomiting, anorexia		■[4]	■	■	■	
Cognitive impairment, personality change		■[4]		■	■	■
Rashes			■	■	■	
Fever, chills			■[6]		■	
Tachycardia		■[4]			■	
Retinal hemorrhage		■[4]				
Myalgia				■[5]		■
Hearing loss				■		

[1]Associated especially with formaldehyde. [2]In asthma. [3]Hypersensitivity pneumonitis, Legionnaires' Disease. [4]Particularly associated with high CO levels. [5]Hypersensitivity pneumonitis, humidifier fever. [6]With marked hypersensitivity reactions and Legionnaires' Disease.

Particular Effects Seen in Infants and Children

Environmental Tobacco Smoke: frequent upper respiratory infections, otitis media; persistent middle-ear effusion; asthma onset, increased severity; recurrent pneumonia, bronchitis.

Acute Lead Toxicity: irritability, abdominal pain, ataxia, seizures, loss of consciousness.

Diagnostic Checklist

It is vital that the individual and the health care professional comprise a cooperative diagnostic team in analyzing diurnal and other patterns that may provide clues to a complaint's link with indoor air pollution. A diary or log of symptoms correlated with time and place may prove helpful. If an association between symptoms and events or conditions in the home or workplace is not volunteered by the individual, answers to the following questions may be useful, together with the medical history.

The health care professional can investigate further by matching the individual's signs and symptoms to those pollutants with which they may be associated, as detailed in the discussions of various pollutant categories.

- When did the [symptom or complaint] begin?
- Does the [symptom or complaint] exist all the time, or does it come and go? That is, is it associated with times of day, days of the week, or seasons of the year?
- (If so) Are you usually in a particular place at those times?
- Does the problem abate or cease, either immediately or gradually, when you leave there? Does it recur when you return?
- What is your work? Have you recently changed employers or assignments, or has your employer recently changed location?
- (If not) Has the place where you work been redecorated or refurnished, or have you recently started working with new or different materials or equipment? (These may include pesticides, cleaning products, craft supplies, et al.)
- What is the smoking policy at your workplace? Are you exposed to environmental tobacco smoke at work, school, home, etc.?
- Describe your work area.
- Have you recently changed your place of residence?
- (If not) Have you made any recent changes in, or additions to, your home?
- Have you, or has anyone else in your family, recently started a new hobby or other activity?
- Have you recently acquired a new pet?
- Does anyone else in your home have a similar problem? How about anyone with whom you work? (An affirmative reply may suggest either a common source or a communicable condition.)

NOTE: A more detailed exposure history form, developed by the U.S. Public Health Service's Agency for Toxic Substances and Disease Registry (ATSDR) in conjunction with the National Institute for Occupational Safety and Health, is available from: Allen Jansen, ATSDR, 1600 Clifton Road, N.E., Mail Drop E33, Atlanta, Georgia 30333, (404) 639-6205. Request *"Case Studies in Environmental Medicine #26: Taking an Exposure History."* Continuing Medical Education Credit is available in conjunction with this monograph.

Health Problems Related To
Environmental Tobacco Smoke

Key Signs/Symptoms in Adults . . .

- rhinitis/pharyngitis, nasal congestion, persistent cough
- conjunctival irritation
- headache
- wheezing (bronchial constriction)
- exacerbation of chronic respiratory conditions

. . . and in Infants and Children

- asthma onset
- increased severity of, or difficulty in controlling, asthma
- frequent upper respiratory infections and/or episodes of otitis media
- persistent middle-ear effusion
- snoring
- repeated pneumonia, bronchitis

Diagnostic Leads

- Is individual exposed to environmental tobacco smoke on a regular basis?
- Test urine of infants and small children for cotinine, a biomarker for nicotine

Remedial Action

While improved general ventilation of indoor spaces may decrease the odor of environmental tobacco smoke (ETS), health risks cannot be eliminated by generally accepted ventilation methods. Research has led to the conclusion that total removal of tobacco smoke—a complex mixture of gaseous and particulate components—through general ventilation is not feasible.[3]

The most effective solution is to eliminate all smoking from the individual's environment, either through smoking prohibitions or by restricting smoking to properly designed smoking rooms. These rooms should be separately ventilated to the outside.[4]

Some higher efficiency air cleaning systems, under select conditions, can remove some tobacco smoke particles. Most air cleaners, including the popular desk-top models, however, cannot remove the gaseous pollutants from this source. And while some air cleaners are designed to remove specific gaseous pollutants, none is expected to remove all of them and should not be relied upon to do so. (For further comment, see p. 21.)

Comment

Environmental tobacco smoke is a major source of indoor air contaminants. The ubiquitous nature of ETS in indoor environments indicates that some unintentional inhalation of ETS by nonsmokers is unavoidable. Environmental tobacco smoke is a dynamic, complex mixture of more than 4,000 chemicals found in both vapor and particle phases. Many of these chemicals are known toxic or carcinogenic agents. Nonsmoker exposure to ETS-related toxic and carcinogenic substances will occur in indoor spaces where there is smoking.

All the compounds found in "mainstream" smoke, the smoke inhaled by the active smoker, are also found in "sidestream" smoke, the emission from the burning end of the cigarette, cigar, or pipe. ETS consists of both sidestream smoke and exhaled mainstream smoke. Inhalation of ETS is often termed "secondhand smoking", "passive smoking", or "involuntary smoking."

The role of exposure to tobacco smoke via active smoking as a cause of lung and other cancers, emphysema and other chronic obstructive pulmonary diseases, and cardiovascular and other diseases in adults has been firmly established[5,6,7]. Smokers, however, are not the only ones affected.

The U.S. Environmental Protection Agency (EPA) has classified ETS as a known human (Group A) carcinogen and estimates that it is responsible for approximately 3,000 lung cancer deaths per year among nonsmokers in the United States[8]. The U.S. Surgeon General, the National Research Council, and the National Institute for Occupational Safety and Health also concluded that passive smoking can cause lung cancer in otherwise healthy adults who never smoked[9,10,11].

Children's lungs are even more susceptible to harmful effects from ETS. In infants and young children up to three years, exposure to ETS causes an approximate doubling in the incidence of pneumonia, bronchitis, and bronchiolitis. There is also strong evidence of increased middle ear effusion, reduced lung function, and reduced lung growth. Several recent studies link ETS with increased incidence and prevalence of asthma and increased severity of asthmatic symptoms in children of mothers who smoke heavily. These respiratory illnesses in childhood may very well contribute to the small but significant lung function reductions associated with exposure to ETS in

adults. The adverse health effects of ETS, especially in children, correlate with the amount of smoking in the home and are often more prevalent when both parents smoke[12].

The connection of children's symptoms with ETS may not be immediately evident to the clinician and may become apparent only after careful questioning. Measurement of biochemical markers such as cotinine (a metabolic nicotine derivative) in body fluids (ordinarily urine) can provide evidence of a child's exposure to ETS[13].

The impact of maternal smoking on fetal development has also been well documented. Maternal smoking is also associated with increased incidence of Sudden Infant Death Syndrome, although it has not been determined to what extent this increase is due to in utero versus postnatal (lactational and ETS) exposure[14].

Airborne particulate matter contained in ETS has been associated with impaired breathing, lung diseases, aggravation of existing respiratory and cardiovascular disease, changes to the body's immune system, and lowered defenses against inhaled particles[15]. For direct ETS exposure, measurable annoyance, irritation, and adverse health effects have been demonstrated in nonsmokers, children and spouses in particular, who spend significant time in the presence of smokers[16,17]. Acute cardiovascular effects of ETS include increased heart rate, blood pressure, blood carboxyhemoglobin; and related reduction in exercise capacity in those with stable angina and in healthy people. Studies have also found increased incidence of nonfatal heart disease among nonsmokers exposed to ETS, and it is thought likely that ETS increases the risk of peripheral vascular disease, as well[18].

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Health Problems Caused By
Other Combustion Products
(Stoves, Space Heaters, Furnaces, Fireplaces)

Key Signs/Symptoms
- dizziness or headache
- confusion
- nausea/emesis
- fatigue
- tachycardia
- eye and upper respiratory tract irritation
- wheezing/bronchial constriction
- persistent cough
- elevated blood carboxyhemoglobin levels
- increased frequency of angina in persons with coronary heart disease

Diagnostic Leads
- What types of combustion equipment are present, including gas furnaces or water heaters, stoves, unvented gas or kerosene space heaters, clothes dryers, fireplaces? Are vented appliances properly vented to the outside?
- Are household members exhibiting influenza-like symptoms during the heating season? Are they complaining of nausea, watery eyes, coughing, headaches?
- Is a gas oven or range used as a home heating source?
- Is the individual aware of odor when a heat source is in use?
- Is heating equipment in disrepair or misused? When was it last professionally inspected?
- Does structure have an attached or underground garage where motor vehicles may idle?
- Is charcoal being burned indoors in a hibachi, grill, or fireplace?

Remedial Action

Periodic professional inspection and maintenance of installed equipment such as furnaces, water heaters, and clothes dryers are recommended. Such equipment should be vented directly to the outdoors. Fireplace and wood or coal stove flues should be regularly cleaned and inspected before each heating season. Kitchen exhaust fans should be exhausted to outside. Vented appliances should be used whenever possible. Charcoal should never be burned inside. Individuals potentially exposed to combustion sources should consider installing carbon monoxide detectors that meet the requirements of Underwriters Laboratory (UL) Standard 2034. No detector is 100% reliable, and some individuals may experience health problems at levels of cardon monoxide below the detection sensitivity of these devices.

Comment

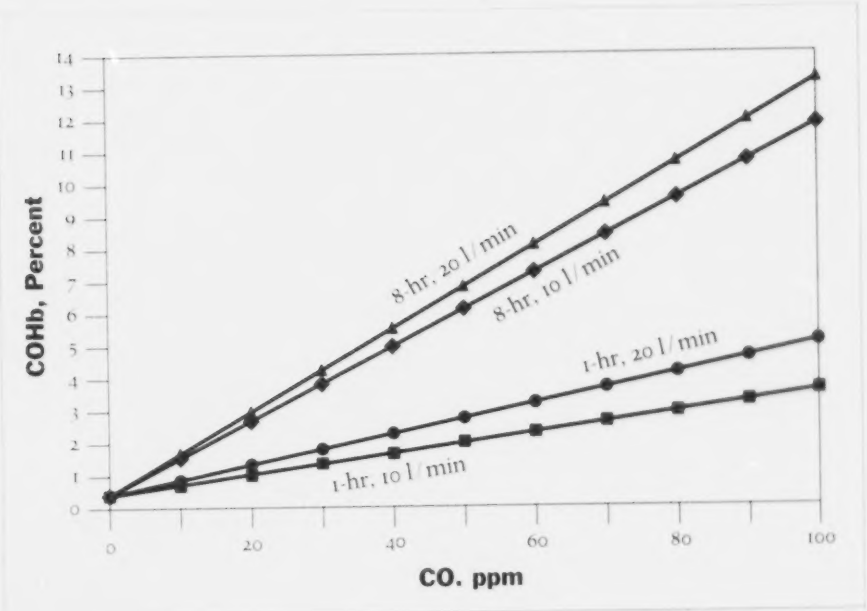
Aside from environmental tobacco smoke, the major combustion pollutants that may be present at harmful levels in the home or workplace stem chiefly from malfunctioning heating devices, or inappropriate, inefficient use of such devices. Incidents are largely seasonal. Another source may be motor vehicle emissions due, for example, to proximity to a garage (or a loading dock located near air intake vents).

A variety of particulates, acting as additional irritants or, in some cases, carcinogens, may also be released in the course of combustion. Although faulty venting in office buildings and other nonresidential structures has resulted in combustion product problems, most cases involve the home or non-work-related consumer activity. Among possible sources of contaminants: gas ranges that are malfunctioning or used as heat sources; improperly flued or vented fireplaces, furnaces, wood or coal stoves, gas water heaters and gas clothes dryers; and unvented or otherwise improperly used kerosene or gas space heaters.

The gaseous pollutants from combustion sources include some identified as prominent atmospheric pollutants—carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2).

Carbon monoxide is an asphyxiant. An accumulation of this odorless, colorless gas may result in a varied constellation of symptoms deriving from the compound's affinity for and combination with hemoglobin, forming carboxyhemoglobin (COHb) and disrupting oxygen transport. The elderly, the fetus, and persons with cardiovascular and pulmonary diseases are particularly sensitive to elevated CO levels. Methylene chloride, found in some common household products, such as paint strippers, can be metabolized to form carbon monoxide which combines with hemoglobin to form COHb. The following chart shows the relationship between CO concentrations and COHb levels in blood.

Tissues with the highest oxygen needs—myocardium, brain, and exercising muscle—are the first affected. Symptoms may mimic influenza and include fatigue, headache, dizziness,



Relationship between carbon monoxide (CO) concentrations and carboxyhemoglobin (COHb) levels in blood

Predicted COHb levels resulting from 1- and 8-hr exposures to carbon monoxide at rest (10 l/min) and with light exercise (20 l/min) are based on the Coburn-Foster-Kane equation using the following assumed parameters for nonsmoking adults: altitude = 0 ft; initial COHb level = 0.5%; Haldane constant = 218; blood volume = 5.5 l; hemoglobin level = 15 g/100 ml; lung diffusivity = 30 ml/torr/min; endogenous rate = 0.007 ml/min.

Source: Raub, J.A. and Grant, L.D. 1989. "Critical health issues associated with review of the scientific criteria for carbon monoxide." Presented at the 82nd Annual Meeting of the Air Waste Management Association. June 25–30. Anaheim, CA. Paper No. 89-54.1. Used with permission.

nausea and vomiting, cognitive impairment, and tachycardia. Retinal hemorrhage on funduscopic examination is an important diagnostic sign[19], but COHb must be present before this finding can be made, and the diagnosis is not exclusive. Studies involving controlled exposure have also shown that CO exposure shortens time to the onset of angina in exercising individuals with ischemic heart disease and decreases exercise tolerance in those with chronic obstructive pulmonary disease (COPD)[20].

Note: Since CO poisoning can mimic influenza, the health care provider should be suspicious when an entire family exhibits such symptoms at the start of the heating season and symptoms persist with medical treatment and time.

Nitrogen dioxide and *sulfur dioxide* act mainly as irritants, affecting the mucosa of the eyes, nose, throat, and respiratory tract. Acute SO_2-related bronchial constriction may also occur in people with asthma or as a hypersensitivity reaction. Extremely high-dose exposure (as in a building fire) to NO_2 may result in pulmonary edema and diffuse lung injury. Continued exposure to high NO_2 levels can contribute to the development of acute or chronic bronchitis.

The relatively low water solubility of NO_2 results in minimal mucous membrane irritation of the upper airway. The principal site of toxicity is the lower respiratory tract. Recent studies indicate that low-level NO_2 exposure may cause

Carboxyhemoglobin levels and related health effects.

% COHb in blood	Effects associated with this COHb level
80	Death[a]
60	Loss of consciousness; death if exposure continues[a]
40	Confusion; collapse on exercise[a]
30	Headache; fatigue; impaired judgement[a]
7–20	Statistically significant decreased maximal oxygen consumption during strenuous exercise in healthy young men[b]
5–17	Statistically significant diminution of visual perception, manual dexterity, ability to learn, or performance in complex sensorimotor tasks (such as driving)[b]
5–5.5	Statistically significant decreased maximal oxygen consumption and exercise time during strenuous exercise in young healthy men[b]
Below 5	No statistically significant vigilance decrements after exposure to CO[b]
2.9–4.5	Statistically significant decreased exercise capacity (i.e., shortened duration of exercise before onset of pain) in patients with angina pectoris and increased duration of angina attacks[b]
2.3–4.3	Statistically significant decreased (about 3–7%) work time to exhaustion in exercising healthy men[b]

Source: [a] U.S. EPA (1979); [b] U.S. EPA (1985)

increased bronchial reactivity in some asthmatics, decreased lung function in patients with chronic obstructive pulmonary disease, and an increased risk of respiratory infections, especially in young children.

The high water solubility of SO_2 causes it to be extremely irritating to the eyes and upper respiratory tract. Concentrations above six parts per million produce mucous membrane irritation. Epidemiologic studies indicate that chronic exposure to SO_2 is associated with increased respiratory symptoms and decrements in pulmonary function[21]. Clinical studies have found that some asthmatics respond with bronchoconstriction to even brief exposure to SO_2 levels as low as 0.4 parts per million[22].

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Health Problems Caused By
Animal Dander, Molds, Dust Mites, Other Biologicals

Key Signs/Symptoms

- recognized infectious disease
- exacerbation of asthma
- rhinitis
- conjunctival inflammation
- recurrent fever
- malaise
- dyspnea
- chest tightness
- cough

Diagnostic Leads

Infectious disease:

- Is the case related to the workplace, home, or other location? (Note: It is difficult to associate a single case of any infectious disease with a specific site of exposure.)
- Does the location have a reservoir or disseminator of biologicals that may logically lead to exposure?

Hypersensitivity disease:

- Is the relative humidity in the home or workplace consistently above 50 percent?
- Are humidifiers or other water-spray systems in use? How often are they cleaned? Are they cleaned appropriately?
- Has there been flooding or leaks?
- Is there evidence of mold growth (visible growth or odors)?
- Are organic materials handled in the workplace?
- Is carpet installed on unventilated concrete (e.g., slab on grade) floors?
- Are there pets in the home?
- Are there problems with cockroaches or rodents?

Toxicosis and/or irritation:

- Is adequate outdoor air being provided?
- Is the relative humidity in the home or workplace above 50 percent or below 30 percent?
- Are humidifiers or other water-spray systems in use?
- Is there evidence of mold growth (visible growth or odors)?
- Are bacterial odors present (fishy or locker-room smells)?

Remedial Action

Provide adequate outdoor air ventilation to dilute human source aerosols.

Keep equipment water reservoirs clean and potable water systems adequately chlorinated, according to manufacturer instructions. Be sure there is no standing water in air conditioners. Maintain humidifiers and dehumidifiers according to manufacturers' instructions.

Repair leaks and seepage. Thoroughly clean and dry water-damaged carpets and building materials within 24 hours of damage, or consider removal and replacement.

Keep relative humidity below 50 percent. Use exhaust fans in bathrooms and kitchens, and vent clothes dryers to outside.

Control exposure to pets.

Vacuum carpets and upholstered furniture regularly. *Note:* While it is important to keep an area as dust-free as possible, cleaning activities often re-suspend fine particles during and immediately after the activity. Sensitive individuals should be cautioned to avoid such exposure, and have others perform the vacuuming, or use a commercially available HEPA (High Efficiency Particulate Air) filtered vacuum.

Cover mattresses. Wash bedding and soft toys frequently in water at a temperature above 130°F to kill dust mites.

Comment

Biological air pollutants are found to some degree in every home, school, and workplace. Sources include outdoor air and human occupants who shed viruses and bacteria, animal occupants (insects and other arthropods, mammals) that shed allergens, and indoor surfaces and water reservoirs where fungi and bacteria can grow, such as humidifiers[23]. A number of factors allow biological agents to grow and be released into the air. Especially important is high relative humidity, which encourages house dust mite populations to increase and allows fungal growth on damp surfaces. Mite and fungus contamination can be caused by flooding, continually damp carpet (which may occur when carpet is installed on poorly ventilated concrete floors), inadequate exhaust of bathrooms, or kitchen-generated moisture[24]. Appliances such as humidifiers, dehumidifiers, air

conditioners, and drip pans under cooling coils (as in refrigerators), support the growth of bacteria and fungi.

Components of mechanical heating, ventilating, and air conditioning (HVAC) systems may also serve as reservoirs or sites of microbial amplification[25]. These include air intakes near potential sources of contamination such as standing water, organic debris or bird droppings, or integral parts of the mechanical system itself, such as various humidification systems, cooling coils, or condensate drain pans. Dust and debris may be deposited in the duct work or mixing boxes of the air handler.

Biological agents in indoor air are known to cause three types of human disease: infections, where pathogens invade human tissues; hypersensitivity diseases, where specific activation of the immune system causes disease; and toxicoses, where biologically produced chemical toxins cause direct toxic effects.

In addition, exposure to conditions conducive to biological contamination (e.g., dampness, water damage) has been related to nonspecific upper and lower respiratory symptoms. Evidence is available that shows that some episodes of the group of nonspecific symptoms known as "sick building syndrome" (see p. 17) may be related to microbial contamination in buildings[26].

Tuberculosis

The transmission of airborne infectious diseases is increased where there is poor indoor air quality[27,28]. The rising incidence of tuberculosis is at least in part a problem associated with crowding and inadequate ventilation. Evidence is increasing that inadequate or inappropriately designed ventilation systems in health care settings or other crowded conditions with high-risk populations can increase the risk of exposure[29].

The incidence of tuberculosis began to rise in the mid-1980s, after a steady decline. The 1989 increase of 4.7 percent to a total of 23,495 cases in the United States was the largest since national reporting of the disease began in 1953, and the number of cases has continued to increase each year[30]. Fresh air ventilation is an important factor in contagion control. Such procedures as sputum induction and collection, bronchoscopy, and aerosolized pentamidine treatments in persons who may be at risk for tuberculosis (e.g., AIDS patients) should be carried out in negative air pressure areas, with air exhausted directly to the outside and away from intake sources[31]. Unfortunately, many health care facilities are not so equipped. Properly installed and maintained ultraviolet irradiation, particularly of upper air levels in an indoor area, is also a useful means of disinfection[32].

Legionnaires' Disease

A disease associated with indoor air contamination is Legionnaires' Disease, a pneumonia that primarily attacks exposed people over 50 years old, especially those who are immunosuppressed, smoke, or abuse alcohol. Exposure to especially virulent strains can also cause the disease in other susceptible populations. The case fatality rate is high, ranging from five to 25 percent. Erythromycin is the most effective treatment. The agent, Legionella pneumophila, has been found in association with cooling systems, whirlpool baths, humidifiers, food market vegetable misters, and other sources, including residential tap water[33]. This bacterium or a closely related strain also causes a self-limited (two- to five-day), flu-like illness without pneumonia, sometimes called Pontiac Fever, after a 1968 outbreak in that Michigan city.

Allergic Reactions

A major concern associated with exposure to biological pollutants is allergic reactions, which range from rhinitis, nasal congestion, conjunctival inflammation, and urticaria to asthma. Notable triggers for these diseases are allergens derived from house dust mites; other arthropods, including cockroaches; pets (cats, dogs, birds, rodents); molds; and protein-containing furnishings, including feathers, kapok, etc. In occupational settings, more unusual allergens (e.g., bacterial enzymes, algae) have caused asthma epidemics. Probably most proteins of non-human origin can cause asthma in a subset of any appropriately exposed population[34].

The role of mites as a source of house dust allergens has been known for 20 years[34,35]. It is now possible to measure mite allergens in the environment and IgE antibody levels in patients using readily available techniques and standardized protocols. Experts have proposed provisional standards for levels of mite allergens in dust that lead to sensitization and symptoms. A risk level where chronic exposure may cause sensitization is 2µg Der pI (Dermatophagoides pteronysinus allergen I) per gram of dust (or 100 mites/g or 0.6 mg guanine/g of dust). A risk level for acute asthma in mite-allergic individuals is 10µg (Der pI) of the allergen per gram of dust (or 500 mites/g of dust).

Controlling house dust mite infestation includes covering mattresses, hot washing of bedding, and removing carpet from bedrooms. For mite allergic individuals, it is recommended that home relative humidities be lower than 45 percent. Mites desiccate in drier air (absolute humidities below 7 kg.). Vacuum cleaning and use of acaricides can be effective short-term remedial strategies. One such acaracide, Acarosan, is registered with EPA to treat carpets, furniture, and beds for dust mites.

Hypersensitivity Pneumonitis

Another class of hypersensitivity disease is hypersensitivity pneumonitis, which may include humidifier fever. Hypersensitivity pneumonitis, also called allergic alveo-litis, is a granulomatous interstitial lung disease caused by exposure to airborne antigens. It may affect from one to five percent or more of a specialized population exposed to appropriate antigens (e.g., farmers and farmers' lung, pigeon breeders and pigeon breeders' disease)[37]. Continued antigen exposure may

lead to end-stage pulmonary fibrosis. Hypersensitivity pneumonitis is frequently misdiagnosed as a pneumonia of infectious etiology. The prevalence of hypersensitivity pneumonitis in the general population is unknown.

Outbreaks of hypersensitivity pneumonitis in office buildings have been traced to air conditioning and humidification systems contaminated with bacteria and molds[38]. In the home, hypersensitivity pneumonitis is often caused by contaminated humidifiers or by pigeon or pet bird antigens. The period of sensitization before a reaction occurs may be as long as months or even years. Acute symptoms, which occur four to six hours postexposure and recur on challenge with the offending agent, include cough, dyspnea, chills, myalgia, fatigue, and high fever. Nodules and nonspecific infiltrates may be noted on chest films. The white blood cell count is elevated, as is specific IgG to the offending antigen. Hypersensitivity pneumonitis generally responds to corticosteroids or cessation of exposure (either keeping symptomatic people out of contaminated environments or removing the offending agents).

Humidifier Fever

Humidifier fever is a disease of uncertain etiology[39]. It shares symptoms with hypersensitivity pneumonitis, but the high attack rate and short-term effects may indicate that toxins (e.g., bacterial endotoxins) are involved. Onset occurs a few hours after exposure. It is a flu-like illness marked by fever, headache, chills, myalgia, and malaise but without prominent pulmonary symptoms. It normally subsides within 24 hours without residual effects, and a physician is rarely consulted. Humidifier fever has been related to exposure to amoebae, bacteria, and fungi found in humidifier reservoirs, air conditioners, and aquaria. The attack rate within a workplace may be quite high, sometimes exceeding 25 percent.

Bacterial and fungal organisms can be emitted from impeller (cool mist) and ultrasonic humidifiers. Mesophilic fungi, thermophilic bacteria, and thermophilic actinomycetes—all of which are associated with development of allergic responses—have been isolated from humidifiers built into the forced-air heating system as well as separate console units. Airborne concentrations of microorganisms are noted during operation and might be quite high for individuals using ultrasonic or cool mist units. Drying and chemical disinfection with bleach or 3% hydrogen peroxide solution are effective remedial measures over a short period, but cannot be considered as reliable maintenance. Only rigorous, daily, and end-of-season cleaning regimens, coupled with disinfection, have been shown to be effective. Manual cleaning of contaminated reservoirs can cause exposure to allergens and pathogens.

Mycotoxins

Another class of agents that may cause disease related to indoor airborne exposure is the mycotoxins. These agents are fungal metabolites that have toxic effects ranging from short-term irritation to immunosuppression and cancer. Virtually all the information related to diseases caused by mycotoxins concerns ingestion of contaminated food[40]. However, mycotoxins are contained in some kinds of fungus spores, and these can enter the body through the respiratory tract. At least one case of neurotoxic symptoms possibly related to airborne mycotoxin exposure in a heavily contaminated environment has been reported[41]. Skin is another potential route of exposure to mycotoxins. Toxins of several fungi have caused cases of severe dermatosis. In view of the serious nature of the toxic effects reported for mycotoxins, exposure to mycotoxin-producing agents should be minimized.

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Health Problems Caused By

Volatile Organic Compounds

(Formaldehyde, Pesticides, Solvents, Cleaning Agents)

Key Signs/Symptoms

- conjunctival irritation
- nose, throat discomfort
- headache
- allergic skin reaction
- dyspnea
- declines in serum cholinesterase levels
- nausea, emesis
- epistaxis (formaldehyde)
- fatigue
- dizziness

Diagnostic Leads

- Does the individual reside in mobile home or new conventional home containing large amounts of pressed wood products?
- Has individual recently acquired new pressed wood furniture?
- Does the individual's job or avocational pursuit include clerical, craft, graphics, or photographic materials?
- Are chemical cleaners used extensively in the home, school, or workplace?
- Has remodeling recently been done in home, school or workplace?
- Has individual recently used pesticides, paints, or solvents?

Remedial Action

Increase ventilation when using products that emit volatile organic compounds, and meet or exceed any label precautions. Do not store opened containers of unused paints and similar materials within home or office. See special note on pesticides.

Formaldehyde is one of the best known volatile organic compound (VOC) pollutants, and is one of the few indoor air pollutants that can be readily measured. Identify, and if possible, remove the source if formaldehyde is the potential cause of the problem. If not possible, reduce exposure: use polyurethane or other sealants on cabinets, paneling and other furnishings. To be effective, any such coating must cover all surfaces and edges and remain intact. Formaldehyde is also used in permanent press fabric and mattress ticking. Sensitive individuals may choose to avoid these products.

Comment

At room temperature, volatile organic compounds are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals (e.g., formaldehyde, benzene, perchloroethylene), some of which may have short- and long-term effects. Concentrations of many VOCs are consistently higher indoors than outdoors. A study by the EPA, covering six communities in various parts of the United States, found indoor levels up to ten times higher than those outdoors—even in locations with significant outdoor air pollution sources, such as petrochemical plants[42].

A wide array of volatile organics are emitted by products used in home, office, school, and arts/crafts and hobby activities. These products, which number in the thousands, include:

- personal items such as scents and hair sprays;
- household products such as finishes, rug and oven cleaners, paints and lacquers (and their thinners), paint strippers, pesticides (see below);
- dry-cleaning fluids
- building materials and home furnishings;
- office equipment such as some copiers and printers;
- office products such as correction fluids and carbonless copy paper[43,44];
- graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions.

Many of these items carry precautionary labels specifying risks and procedures for safe use; some do not. Signs and symptoms of VOC exposure may include eye and upper respiratory irritation, rhinitis, nasal congestion, rash, pruritus, headache, nausea, vomiting, dyspnea and, in the case of formaldehyde vapor, epistaxis.

Formaldehyde

Formaldehyde has been classified as a probable human carcinogen by the EPA[45]. Urea-formaldehyde foam insulation (UFFI), one source of formaldehyde used in home construction until the early 1980s, is now seldom installed, but formaldehyde-based resins are components of finishes, plywood, paneling, fiberboard, and particleboard, all widely employed in mobile and conventional home construction as building materials (subflooring, paneling) and as components

of furniture and cabinets, permanent press fabric, draperies, and mattress ticking.

Airborne formaldehyde acts as an irritant to the conjunctiva and upper and lower respiratory tract. Symptoms are temporary and, depending upon the level and length of exposure, may range from burning or tingling sensations in eyes, nose, and throat to chest tightness and wheezing. Acute, severe reactions to formaldehyde vapor—which has a distinctive, pungent odor—may be associated with hypersensitivity. It is estimated that 10 to 20 percent of the U.S. population, including asthmatics, may have hyperreactive airways which may make them more susceptible to formaldehyde's effects[46].

Pesticides

Pesticides sold for household use, notably impregnated strips, and foggers or "bombs", which are technically classed as semi-volatile organic compounds, include a variety of chemicals in various forms. Exposure to pesticides may cause harm if they are used improperly. However, exposure to pesticides via inhalation of spray mists may occur during normal use. Exposure can also occur via inhalation of vapors and contaminated dusts after use (particularly to children who may be in close contact with contaminated surfaces). Symptoms may include headache, dizziness, muscular weakness, and nausea. In addition, some pesticide active ingredients and inert components are considered possible human carcinogens. Label directions must be explicitly followed[47].

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[46] U.S. Environmental Protection Agency, U.S. Public Health Service, and National Environmental Health Association. *Introduction to Indoor Air Quality: A Reference Manual*, p. 87. EPA-400-3-91-003, 1991.

[47] U.S. Environmental Protection Agency Office of Research and Development. *Final Report: Nonoccupational Pesticide Exposure Study (NOPES)*, p. 60. EPA-600-3-90-003, 1990.

Health Problems Caused By

Heavy Metals: Airborne Lead and Mercury Vapor

Key Signs/Symptoms of Lead Poisoning in Adults . . .

- gastrointestinal discomfort/constipation/anorexia/nausea
- fatigue, weakness
- personality changes
- headache
- hearing loss
- tremor, lack of coordination

. . . and in Infants and Small Children

- irritability
- abdominal pain
- ataxia
- seizures/loss of consciousness
- (chronic) learning deficits
- hyperactivity, reduced attention span

Key Signs/Symptoms of Mercury Poisoning

- muscle cramps or tremors
- headache
- tachycardia
- intermittent fever
- acrodynia
- personality change
- neurological dysfunction

Diagnostic Leads

- Does the family reside in old or restored housing?
- Has renovation work been conducted in the home, workplace, school, or day care facility?
- Is the home located near a busy highway or industrial area?
- Does the individual work with lead materials such as solder or automobile radiators?
- Does the child have sibling, friend, or classmate recently diagnosed with lead poisoning?
- Has the individual engaged in art, craft, or workshop pursuits?
- Does the individual regularly handle firearms?
- Has the home interior recently been painted with latex paint that may contain mercury?
- Does the individual use mercury in religious or cultural activities?

Remedial Action

Wet-mop and wipe furniture frequently to control lead dust. Have professional remove or encapsulate lead containing paint; individuals involved in this and other high exposure activities should use appropriate protective gear and work in well-ventilated areas. Do not burn painted or treated wood.

Comment

Airborne Lead

Most health professionals are aware of the threat of lead toxicity, particularly its long term impact on children in the form of cognitive and developmental deficits which are often cumulative and subtle. Such deficits may persist into adulthood[48]. According to the American Academy of Pediatrics, an estimated three to four million children in the U.S. under age six have blood lead levels that could cause impaired development, and an additional 400,000 fetuses are at similar risk[49].

Lead toxicity may alternatively present as acute illness. Signs and symptoms in children may include irritability, abdominal pain, emesis, marked ataxia, and seizures or loss of consciousness. In adults, diffuse complaints—including headache, nausea, anorexia (and weight loss), constipation, fatigue, personality changes, and hearing loss—coupled with exposure opportunity may lead to suspicion of lead poisoning.

Lead inhibits heme synthesis. Since interruption of that process produces protoporphyrin accumulation at the cellular level, the standard screening method is investigation of blood lead (PbB) levels which reveal recent exposure to lead. Acute symptomology in adults is often associated with PbB at levels of 40 µg/dl or higher. There is good evidence for adverse effects of lead in very young children at much lower levels.[50,51] The Centers for Disease Control and Prevention has set 10 µg/dl as the level of concern[52]. Increased maternal Pb exposure has also been deemed significant in pregnancy, since an umbilical cord PbB of greater than 10 µg/dl has been correlated with early developmental deficits. If sufficiently high PbB levels are confirmed, chelation therapy may be indicated. Suspected low level lead contamination cannot be accurately identified by a

erythrocyte protoporphyrin (EP) finger-stick test, but requires blood lead analysis.

Lead poisoning via ingestion has been most widely publicized, stressing the roles played by nibbling of flaking paint by infants and toddlers and by the use of lead-containing foodware (glass, and soldered metal-ceramic ware) by adults. Lead dust flaking or "chalking" off lead painted walls generated by friction surfaces is a major concern. Airborne lead, however, is also a worrisome source of toxicity. There is no skin absorption associated with inorganic lead.

Airborne lead outdoors, originating chiefly from gasoline additives, has been effectively controlled since the 1980s through regulation at the federal level. Much of this lead still remains in the soil near heavily trafficked highways and in urban areas, however, and can become airborne at times. It may enter dwellings via windows and doors, and contaminated soil can also be tracked inside.

Indoors, the chief source is paint. Lead levels in paints for interior use have been increasingly restricted since the 1950s, and many paints are now virtually lead free. But older housing and furniture may still be coated with leaded paint, sometimes surfacing only after layers of later, non-lead paint have flaked away or have been stripped away in the course of restoration or renovation. In these circumstances, lead dust and fumes can permeate the air breathed by both adults and children.

Additional sources of airborne lead include art and craft materials, from which lead is not banned, but the U.S. Consumer Product Safety Commission (CPSC) requires its presence to be declared on the product label if it is present in toxic amounts. Significant quantities are found in many paints and glazes, stained glass, as well as in some solder. Hazardous levels of atmospheric lead have been found at police and civilian firing ranges. Repair and cleaning of automobile radiators in inadequately ventilated premises can expose workers to perilous levels of airborne lead. The use of treated or painted wood in fireplaces or improperly vented wood stoves may release a variety of substances, including lead and other heavy metals, into the air.

Mercury Vapor

While old paint has been the most publicized source of airborne heavy metal (i.e., lead), new paint has emerged as a concern as well. A 1990 report detailed elevated levels of mercury in persons exposed to interior latex (water-based) paint containing phenylmercuric acetate[53]. PMA was a preservative that was used to prolong the product's shelf life.

Initial action by the U.S. Environmental Protection Agency resulted in the elimination of mercury compounds from indoor latex paints at the point of manufacture as of August 1990, with the requirement that paints containing mercury, including existing stocks originally designed for indoor use, be labeled or relabeled "For Exterior Use Only". As of September 1991, phenylmercuric acetate is forbidden in the manufacture of exterior latex paints as well. Latex paints containing hazardous levels of mercury may still remain on store shelves or in homes where they were left over after initial use, however.

An additional matter of concern, recently noted by the CPSC, is the sprinkling of mercury about the home by some ethnic / religious groups[54]. According to the CPSC, mercury for this purpose is purveyed by some herbal medicine or botanical shops to consumers unaware of the dangers of the substance.

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Health Problems Caused By
Sick Building Syndrome

Key Signs/Symptoms
- lethargy or fatigue
- headache, dizziness, nausea
- irritation of mucous membranes
- sensitivity to odors

Diagnostic Leads
- Are problems temporally related to time spent in a particular building or part of a building?
- Do symptoms resolve when the individual is not in the building?
- Do symptoms recur seasonally (heating, cooling)?
- Have co-workers, peers noted similar complaints?

Remedial Action

Appropriate persons—employer, building owner or manager, building investigation specialist, if necessary state and local government agency medical epidemiologists and other public health officials—should undertake investigation and analysis of the implicated building, particularly the design and operation of HVAC systems, and correct contributing conditions. Persistence on the part of individual(s) and health care consultant(s) may be required to diagnose and remediate the building problems.

Comment

The term "sick building syndrome" (SBS), first employed in the 1970s, describes a situation in which reported symptoms among a population of building occupants can be temporally associated with their presence in that building. Typically, though not always, the structure is an office building.

Generally, a spectrum of specific and nonspecific complaints are involved. Typical complaints, in addition to the signs and symptoms already listed, may also include eye and/or nasopharyngeal irritation, rhinitis or nasal congestion, inability to concentrate, and general malaise—complaints suggestive of a host of common ailments, some ubiquitous and easily communicable. The key factors are commonality of symptoms and absence of symptoms among building occupants when the individuals are not in the building.

Sick building syndrome should be suspected when a substantial proportion of those spending extended time in a building (as in daily employment) report or experience acute on-site discomfort. It is important, however, to distinguish SBS from problems of building related illness. The latter term is reserved for situations in which signs and symptoms of diagnosable illness are identified and can be attributed directly to specific airborne building contaminants. Legionnaires' Disease and hypersensitivity pneumonitis, for example, are building related illnesses.

There has been extensive speculation about the cause or causes of SBS. Poor design, maintenance, and/or operation of the structure's ventilation system may be at fault[55]. The ventilation system itself can be a source of irritants. Interior redesign, such as the rearrangement of offices or installation of partitions, may also interfere with efficient functioning of such systems.

Another theory suggests that very low levels of specific pollutants, including some discussed in the preceding pages, may be present and may act synergistically, or at least in combination, to cause health effects. Humidity may also be a factor: While high relative humidity may contribute to biological pollutant problems, an unusually low level—below 20 or 30 percent—may heighten the effects of mucosal irritants and may even prove irritating itself. Other contributing elements may include poor lighting and adverse ergonomic conditions, temperature extremes, noise, and psychological stresses that may have both individual and interpersonal impact.

The prevalence of the problem is unknown. A 1984 World Health Organization report suggested that as many as 30 percent of new and remodeled buildings worldwide may generate excessive complaints related to indoor air quality[56]. In a nationwide, random sampling of U.S. office workers, 24 percent perceived air quality problems in their work environments, and 20 percent believed their work performance was hampered thereby[57].

When SBS is suspected, the individual physician or other health care provider may need to join forces with others (e.g., clinicians consulted by an individual's co-workers, as well as industrial hygienists and public health officials) to adequately investigate the problem and develop appropriate solutions.

References

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Health Problems Caused By
Two Long-Term Risks: Asbestos and Radon

Asbestos and radon are among the most publicized indoor air pollutants. Both are known human carcinogens. Their carcinogenic effects are not immediate but are evident only years, even decades, after prolonged exposure.

Asbestos

Once widely used in structural fireproofing, asbestos may be found predominantly in heating systems and acoustic insulation, in floor and ceiling tiles, and in shingles in many older houses. It was formerly used in such consumer products as fireplace gloves, ironing board covers, and certain hair dryers.

When asbestos-containing material is damaged or disintegrates with age, microscopic fibers may be dispersed into the air. Over as long as twenty, thirty, or more years, the presence of these fibers within the lungs may result in asbestosis (asbestos-caused fibrosis of the lung, seen as a result of heavy occupational exposure)[58], lung cancer and pleural or peritoneal cancer, or mesothelioma[59]. For lung cancer, the effect of tobacco smoking in combination with asbestos exposure appears to be synergistic by approximately fivefold[60]. Occupational exposure may also be associated with increased risk of gastrointestinal malignancies. Attention should be focused on those populations with continual exposure and documented health effects, e.g. maintenance workers.

Products and materials containing asbestos are not necessarily so labeled. Construction professionals or state or local environmental agencies may inspect and analyze suspect materials. Manufacturers of particular products may also be able to supply information.

The risk of disease depends on exposure to airborne asbestos fibers. Average levels in buildings are low, and the risk to building occupants is therefore low.

Removal of asbestos is not always the best choice to reduce exposure. The EPA requires asbestos removal only in order to prevent significant public exposure and generally recommends an in-place management program when asbestos has been discovered and is in good condition[61].

Radon

Radon is the second leading cause of lung cancer, following smoking. Radon is odorless, colorless, and tasteless. It is a naturally occurring radioactive gas resulting from the decay of radium, itself a decay product of uranium. Radon in turn breaks down into radon decay products, short-lived radionuclides. These decay products, either free or attached to airborne particles, are inhaled, and further decay can take place in the lungs before removal by clearance mechanisms.

It is the emission of high-energy alpha particles during the radon decay process that increases the risk of lung cancer. While the risk to underground miners has long been known, the potential danger of residential radon pollution has been widely recognized only since the late 1970s, with the documentation of high indoor levels.

When radon decay products are inhaled and deposited in the lungs, the alpha emissions penetrate the cells of the epithelium lining the lung. Energy deposited in these cells during irradiation is believed to initiate the process of carcinogenesis. The EPA, the National Cancer Institute, the Centers for Disease Control and Prevention, and others estimate that thousands of lung cancer deaths per year are attributable to radon, based on data from epidemiologic studies of thousands of underground miners and from animal studies. Lung cancer is presently the only commonly accepted disease risk associated with radon.

Tobacco smoke in combination with radon exposure has a synergistic effect. Smokers and former smokers are believed to be at especially high risk. Scientists estimate that the increased risk of lung cancer to smokers from radon exposure is ten to twenty times higher than to people who have never smoked.

The EPA estimates that as many as six million homes throughout the country have elevated levels of radon. Since 1988, EPA and the Office of the Surgeon General have recommended that homes below the third floor be tested for radon.

Short term testing is the quickest way to determine if a potential problem exists, taking from two to ninety days to complete. Low-cost radon test kits are available by mail order, in hardware stores, and through other retail outlets[62].

Measurement devices should be state-certified or display the phrase, "Meets EPA Requirements". Trained contractors who meet EPA's requirements can also provide testing services. The most commonly used devices are charcoal canisters, electret ion detectors, alpha track detectors, and continuous monitors

placed by contractors. Short term testing should be conducted in the lowest lived in area of the home, with the doors and windows shut. Long term testing can take up to a full year but is more likely to reflect the home's year round average radon level than short term testing. Alpha track detectors and electret ion detectors are the most common long-term testing devices.

Corrective steps include sealing foundation cracks and holes, and venting radon-laden air from beneath the foundation. Professional expertise should be sought for effective execution of these measures.

References

[58] The first death attributed to occupational asbestos exposure occurred in 1924; the details were recently recounted: Selikoff, I.J. and Greenberg, M. "A Landmark Case in Asbestosis." *Journal of the American Medical Association* 1991; 265:898-901.

[59] For a detailed discussion of asbestos-related pulmonary disease, see: Rom, W.N., Travis, W.D. and Brody, A.R. "Cellular and Molecular Basis of the Asbestos-related Diseases." *American Review of Respiratory Disease* 1991; 143:408-22.

[60] U.S. Environmental Protection Agency, Office of Research and Development. Airborne Asbestos Health Assessment Update. EPA-600/8-84-003F. June 1986.

[61] "Asbestos in Your Home", American Lung Association, U.S. Consumer Product Safety Commission, U.S. Environmental Protection Agency. September 1990. ALA Publication No. 3716.

[62] See Samet, J.M., Marbury, Marian C. and Spengler, J.D. "Health Effects and Sources of Indoor Air Pollution, Part II." *American Review of Respiratory Disease* 1988; 137:221-42. This continuation of the overview cited earlier provides a table of commercial sources of testing equipment for sampling and monitoring levels of a variety of indoor air pollutants, including radon.

Questions That May Be Asked

The subject of indoor air pollution is not without some controversy. Indoor air quality is an evolving issue; it is important to keep informed about continuing developments in this area. The following questions may be asked of physicians and other health professionals.

What is "multiple chemical sensitivity" or "total allergy"?
The diagnostic label of multiple chemical sensitivity (MCS)—also referred to as "chemical hypersensitivity" or "environmental illness"—is being applied increasingly, although definition of the phenomenon is elusive and its pathogenesis as a distinct entity is not confirmed. Multiple chemical sensitivity has become more widely known and increasingly controversial as more patients received the label[63].

Persons with the diagnostic label of multiple chemical sensitivity are said to suffer multi-system illness as a result of contact with, or proximity to, a spectrum of substances, including airborne agents. These may include both recognized pollutants discussed earlier (such as tobacco smoke, formaldehyde, et al.) and other pollutants ordinarily considered innocuous. Some who espouse the concept of MCS believe that it may explain such chronic conditions as some forms of arthritis and colitis, in addition to generally recognized types of hypersensitivity reactions.

Some practitioners believe that the condition has a purely psychological basis. One study[63] reported a 65 percent incidence of current or past clinical depression, anxiety disorders, or somatoform disorders in subjects with this diagnosis compared with 28 percent in controls. Others, however, counter that the disorder itself may cause such problems[64], since those affected are no longer able to lead a normal life, or that these conditions stem from effects on the nervous system[65].

The current consensus is that in cases of claimed or suspected MCS, complaints should not be dismissed as psychogenic, and a thorough workup is essential. Primary care givers should determine that the individual does not have an underlying physiological problem and should consider the value of consultation with allergists and other specialists.

Who are "clinical ecologists"?
"Clinical ecology", while not a recognized conventional medical specialty, has drawn the attention of health care professionals as well as laypersons. The organization of clinical ecologists—physicians who treat individuals believed to be suffering from "total allergy" or "multiple chemical sensitivity"—was founded as the Society for Clinical Ecology and is now known as the American Academy of Environmental Medicine. Its ranks have attracted allergists and physicians from other traditional medical specialties[66].

What are ionizers and other ozone generating air cleaners?
Ion generators act by charging the particles in a room so that they are attracted to walls, floors, tabletops, draperies, occupants, etc. Abrasion can result in these particles being resuspended into the air. In some cases these devices contain a collector to attract the charged particles back to the unit. While ion generators may remove small particles (e.g., those in tobacco smoke) from the indoor air, they do not remove gases or odors, and may be relatively ineffective in removing large particles such as pollen and house dust allergens. Although some have suggested that these devices provide a benefit by rectifying a hypothesized ion imbalance, no controlled studies have confirmed this effect.

Ozone, a lung irritant, is produced indirectly by ion generators and some other electronic air cleaners and directly by ozone generators. While indirect ozone production is of concern, there is even greater concern with the direct, and purposeful introduction of a lung irritant into indoor air. There is no difference, despite some marketers' claims, between ozone in smog outdoors and ozone produced by these devices. Under certain use conditions ion generators and other ozone generating air cleaners can produce levels of this lung irritant significantly above levels thought harmful to human health. A small percentage of air cleaners that claim a health benefit may be regulated by FDA as a medical device. The Food and Drug Administration has set a limit of 0.05 parts per million of ozone for medical devices. Although ozone can be useful in reducing odors and pollutants in unoccupied spaces (such as removing smoke odors from homes involved in fires) the levels needed to achieve this are above those generally thought to be safe for humans.

Can other air cleaners help?
Ion generators and ozone generators are types of air cleaners; others include mechanical filter air cleaners, electronic air cleaners (e.g., electrostatic precipitators), and hybrid air cleaners utilizing two or more techniques. Generally speaking, existing air

cleaners are not appropriate single solutions to indoor air quality problems, but can be useful as an adjunct to effective source control and adequate ventilation. Air cleaning alone cannot adequately remove all pollutants typically found in indoor air.

The value of any air cleaner depends upon a number of factors, including its basic efficiency, proper selection for the type of pollutant to be removed, proper installation in relation to the space, and faithful maintenance. Drawbacks, varying with type, may include inadequate pollutant removal, re-dispersement of pollutants, deceptive masking rather than removal, generation of ozone, and unacceptable noise levels.

The EPA and CPSC have not taken a position either for or against the use of these devices in the home[67].

Should I have my ducts cleaned?

As awareness of the importance of indoor air quality grows, more people are looking at duct cleaning as a way to solve indoor air quality problems. Individuals considering having ducts cleaned should determine that contaminated ducts are the cause of their health problems. Even when contaminants are found in ducts, the source may lie elsewhere, and cleaning ducts may not permanently solve the problem. The duct cleaning industry is expanding to meet demand, using extensive advertising to encourage people to use their services. Individuals who employ such services should verify that the service provider takes steps to protect individuals from exposure to dislodged pollutants and chemicals used during the cleaning process. Such steps may range from using HEPA filtration on cleaning equipment, providing respirators for workers, and occupants vacating the premises during cleaning.

Can carpet make people sick?

Like many other household products and furnishings, new carpet can be a source of chemical emissions. Carpet emits volatile organic compounds, as do products that accompany carpet installation such as adhesives and padding. Some people report symptoms such as eye, nose and throat irritation; headaches; skin irritations; shortness of breath or cough; and fatigue, which they may associate with new carpet installation. Carpet can also act as a "sink" for chemical and biological pollutants including pesticides, dust mites, and fungi.

Individuals purchasing new carpet should ask retailers for information to help them select lower emitting carpet, cushion, and adhesives. Before new carpet is installed, they should ask the retailer to unroll and air out the carpet in a clean, well-ventilated area. They should consider leaving the premises during and immediately after carpet installation or schedule the installation when the space is unoccupied. Opening doors and windows and increasing the amount of fresh air indoors will reduce exposure to most chemicals released from newly installed carpet. During and after installation in a home, use of window fans and room air conditioners to exhaust fumes to the outdoors is recommended. Ventilation systems should be in proper working order, and should be operated during installation, and for 48 to 72 hours after the new carpet is installed.

Individuals should request that the installer follow the Carpet and Rug Institute's installation guidelines[68]. If new carpet has an objectionable odor, they should contact their carpet retailer. Finally, carpet owners should follow the manufacturer's instructions for proper carpet maintenance.

Can plants control indoor air pollution?

Recent reports in the media and promotions by the decorative houseplant industry characterize plants as "nature's clean air machine", claiming that National Aeronautics and Space Administration (NASA) research shows plants remove indoor air pollutants. While it is true that plants remove carbon dioxide from the air, and the ability of plants to remove certain other pollutants from water is the basis for some pollution control methods, the ability of plants to control indoor air pollution is less well established. Most research to date used small chambers without any air exchange which makes extrapolation to real world environments extremely uncertain. The only available study of the use of plants to control indoor air pollutants in an actual building could not determine any benefit from the use of plants[69]. As a practical means of pollution control, the plant removal mechanisms appear to be inconsequential compared to common ventilation and air exchange rates. In other words, the ability of plants to actually improve indoor air quality is limited in comparison with provision of adequate ventilation.

While decorative foliage plants may be aesthetically pleasing, it should be noted that overdamp planter soil conditions may actually promote growth of unhealthy micro-organisms.

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68 Residential Carpet Installation Standard. The Carpet and Rug Institute. First Edition. 1990. CRI Publication No. 105 1990.

69 National Aeronautics and Space Administration. Interior Landscape Plants for Indoor Air Pollution Abatement. September 15, 1989.

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For Assistance and Additional Information

For assistance and guidance in dealing with known or suspected adverse effects of indoor air pollution, contact the U.S. Environmental Protection Agency Indoor Air Quality Information Clearinghouse (1-800-438-4318), EPA regional offices, and state and local departments of health and environmental quality, and your local American Lung Association (1-800-LUNG-USA).

For information on particular product hazards, contact the U.S. Consumer Product Safety Commission (1-800-638-CPSC). Individual manufacturers, as well as trade associations, may also supply pertinent information.

For information about regulation of specific pollutants, call the EPA Toxic Substances Control Act (TSCA) Assistance Information Service (202-554-1404).

For information relating to occupational exposures, contact the Occupational Safety and Health Administration (202-523-6091) or the National Institute of Occupational Safety and Health (1-800-35-NIOSH).

For information on lead, contact the National Lead Information Center (1-800-LEAD FYI). For information on pesticides, contact the National Pesticides Telecommunications Network (1-800-858-PEST).

Many sources of information are listed in the references at the end of each chapter. The following publications may also be useful to the health professional and to the patient.

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For the health professional:

American Lung Association. "Health Effects and Sources of Indoor Air Pollution, Parts I and II". 1989. Publication No. 0857C.

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Wadden, R.A., Scheff, P.A. *Indoor Air Pollution — Characterization, Prediction, and Control*. 1983. John Wiley and Sons, Inc. New York, NY.

For the patient (may be helpful to the professional as well):

American Lung Association. "Air Pollution In Your Home?". 1990. Publication No. 1001C.

American Lung Association. "Home Indoor Air Quality Checklist". 1992. Publication No. 0679C.

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U.S. Environmental Protection Agency. "Targeting Indoor Air Pollution — EPA's Approach and Progress". September 1992. EPA-400-R-92-012.

Environmental Tobacco Smoke

For the health professional:

Bascom, R., Kulle T., Kagey-Sobotka A., Proud, D. "Upper Respiratory Tract Environmental Tobacco Smoke Sensitivity". *American Review of Respiratory Disease*. 1991. 143:1304–1311.

International Cancer Information Center. "Selected Abstracts on Environmental Tobacco Smoke and Cancer". National Cancer Institute. *Oncology Reviews* series. October 1989.

For the patient (may be helpful to the professional as well):

American Lung Association. "Indoor Air Pollution Fact Sheet - Secondhand Smoke". 1989. Publication No. 1185c.

American Lung Association. "Reducing the Health Risks of Secondhand Smoke". 1992. Publication No. 1085.

U.S. Environmental Protection Agency. "Respiratory Health Effects of Passive Smoking" Fact Sheet. January 1993.

U.S. Environmental Protection Agency. "What You Can Do About Secondhand Smoke". July 1993. EPA-404-F-93-004.

Combustion Products

For the patient (may be helpful to the professional as well):

American Lung Association. "Indoor Air Pollution Fact Sheet - Combustion Products". 1992. Publication No. 1182c.

U.S. Consumer Product Safety Commission, U.S. Environmental Protection Agency, American Lung Association. "What You Should Know About Combustion Appliances and Indoor Air Pollution". 1991. ALA Publication No. 3717c.

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